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STATUS, TECHNOLOGIES AND STRATEGIES FOR INCREASING OILSEEDS PRODUCTION IN INDIA

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ABSTRACT

Vegetable oil shortage is a major concern for Indian economy to spend significant foreign exchange on import bill to meet more than 50% requirement of the country. The domestic oilseeds production is not meeting the pace of demand for vegetable oils driven by increased population with increased standard of living and growing industrial need. The demand for vegetable oil and oilseeds is increasing due to increase in population, increased standard of living and rapid industrialization. The *per capita* consumption of vegetable oils is rising continuously surpassing 18 kg/year during 2015-16. During the last two decades, edible oil consumption increased at a 4.3% compound annual growth rate and is expected to continue. The demand projections taking into account the trend of expenditure and price of food items suggest that the edible oil demand in the country to be 19.02 and 40.89 m t for 2025 and 2050. The future projection puts further concern with additional dimension of demand for biofuels. Despite the country is bestowed with wide agro-climatic situations for growing myriad oilseed crops, the productivity of annual oilseed crops in the country is low due to the sub-optimal agro-ecological growing conditions of majority rainfed cultivation (64%) and with inadequate and imbalanced nutrition especially of S, B and Zn, persistent biotic stresses and mostly grown by majority small and marginal farmers with low investment and management capacity. Besides, the production economics of oilseeds is discouraging in comparison with other competing crops.The strategies for research, development and policy for increasing oilseeds production in short and long term basis have been crafted for priority persuasion. With the desired policy support of ensured MSP, liberal support for expanding irrigation facility, small holding mechanization and oil content based premium pricing would provide fillip for higher technology adoption.

STATUS OF OILSEEDS AND VEGETABLE OILS

India is one of the largest oilseeds producing countries with largest area under oilseeds sharing 14% of the country's gross cropped area and accounting for nearly 1.4% of the gross domestic product and 8% of the value of all agricultural products. India contributes about 6-7% of the world oilseeds production. India has the distinction of having highest production and consumption of oilseeds and vegetable oils. But the production falls far short of consumption. Oilseeds are cultivated in 25.73 million ha with a production of 26.67 million tones with a productivity of 1037 kg ha^{-1} from nine annual oilseed crops (2014-15). Currently, the vegetable oil need of the country is being met from more than 50% imports (14 million tonnes) at a cost of Rs.69717 crores on import bill (2015-16). Paradoxically, despite the opportunity of cultivating nine annual oilseed crops under wide ranging agro-ecological situations and recording highest acreage under oilseeds, India remained the world's second-largest edible oil consumer after China, meeting more than half its annual requirement through imports.

The demand for vegetable oil and oilseeds is increasing due to increase in population, increased standard of living and rapid industrialization. Vegetable oil consumption is both price and income elastic. The National Council of Applied Economic Research (NCAER) has projected the demand for edible oils in India under three scenarios on the basis of *per capita* income growing annually by 4%, 5% and 6%. The demand projections taking into account the trend of expenditure and price of food items suggest that the edible oil demand in the country to be 19.02 and 40.89 mt for 2025 and 2050 respectively (Singh, 2006). India's oilseed deficit is likely to continue owing to an ongoing production shortage coupled with robust demand growth. The *per capita* consumption of vegetable oils is rising continuously surpassing 18 kg $year^{-1}$ during 2015-16. During the last two decades, edible oil consumption increased at a 4.3% compound annual growth rate and is expected to continue increasing with the growing population, changing demographic pattern and rising *per capita* consumption. This apart, across the world, the new dimension to demand for vegetable oil comes from the unlimited demand for biofuel due to the commitments under UN Kyoto protocol for binding emission reduction. Oilseeds are most sought renewable source of vegetable oil for biofuel production.

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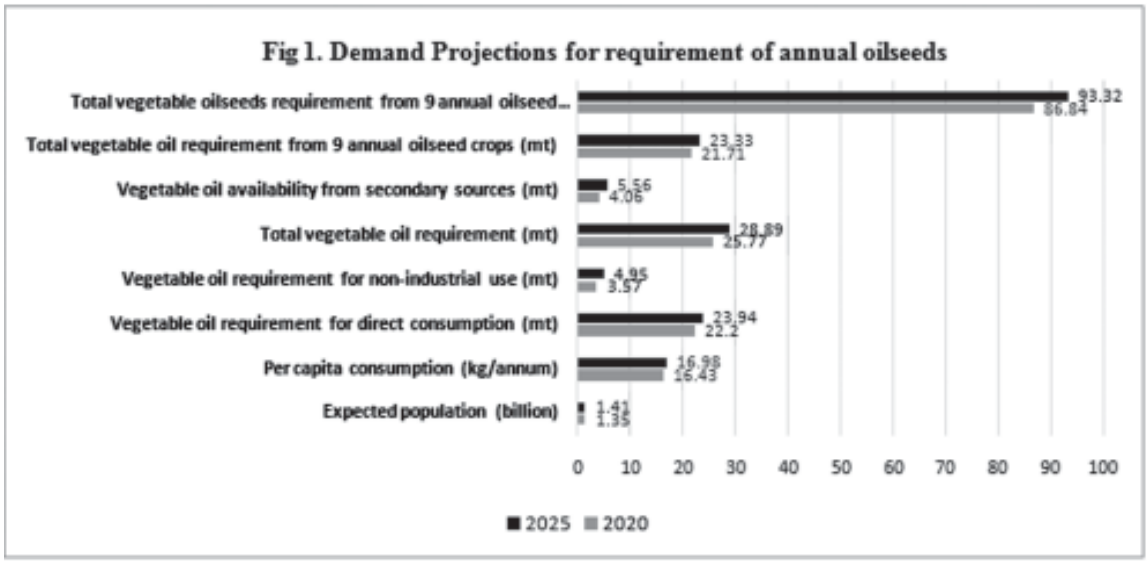

Total vegetable oil requirement in the country for 2020 and 2025 has been estimated to be 25.77 and 28.89 mt including the estimated requirement of 3.57 and 4.95 mt for non-industrial use. The vegetable oil availability from secondary sources such as coconut, cotton seed, rice bran, SEO and tree & forest origin has been estimated to the tune of 4.06 and 5.56 mt by 2020 and 2025, respectively (Fig 1). Thereby, the vegetable oil requirement from the nine annual oilseeds would be around 21.21 and 23.33 mt necessitating the oilseeds production to the tune of 86.84 and 93.32 mt by 2020 and 2025, respectively.

The growth rates of all annual oilseed crops during past decade (2001-02 to 2011-12) is poor (negative for area and production) especially for sunflower, safflower, linseed, niger; and negative for area of groundnut (Fig 2). Soybean and castor crops have registered positive and high growth rates and rapeseed-mustard registered higher rate of production. The higher productivity driving the production (and profitability!) and area expansion of castor is the best situation for oilseeds. The annual production of oilseeds is increasing continuously in the country and showed a positive growth during the period 2001 to 2013 compared to the decade 1990-2000 especially as the increased production has come from the increase in area and highest rate of increase for productivity implying the technology led growth.

The diverse agro-ecological conditions in the country are favourable for growing all the nine annual oilseeds, which include seven edible oilseeds *viz.,* groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower, niger and two non-edible sources *viz.,* castor and linseed. One or more oilseed crops are cultivated in every state in the country. Madhya Pradesh, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu and Uttar

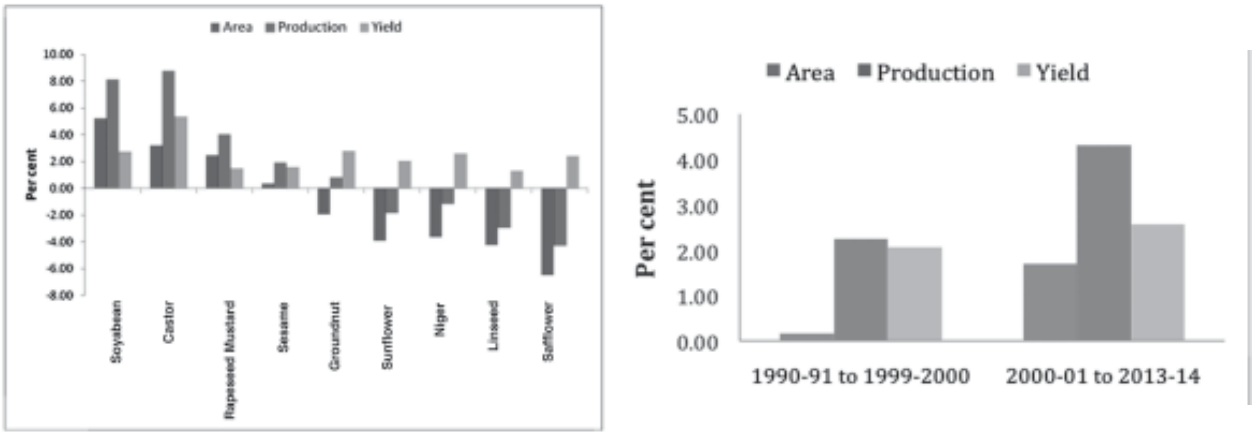

Fig. 2. Compound growth rates of annual oilseed crops in India

Pradesh account for nearly 90% of oilseeds area and production in the country. Among different oilseeds, groundnut, rapeseed-mustard and soybean account for nearly 80% of oilseeds area and 90% of oilseeds production in the country (Table 1).There is also a high degree of variation in annual production of oilseeds owing to their cultivation predominantly under low and uncertain rainfall situations and input starved conditions coupled with poor crop management. Oilseeds and rainfed farming are synonymous as most of the nine annual oilseed crops are grown rainfed with only 26% of area under irrigation that too area under oilseeds is rainfed and the oilseeds production in the country is directly varies as per the rainfall pattern. Besides, of the factors under the control, oilseed crops are grown in situations of low resource base and input use, thus resulting in low and uncertain production owing to their cultivation with poor crop management by a majority of small and marginal farmers. This further leads to low investment in oilseeds production. Majority of oilseed growers (>85%) are small and marginal farmers. The high genetic potential of the newer genotypes can be realized only when the optimum agro-ecological

Table 1. Area, Production and yield of oilseed crops in India (2014-15)

S. No	Crop	Area	Production	Productivity (kg ha^{-1})	World average yield (kg ha^{-1})
1.	Groundnut	4.68	6.56	1400	1648
2.	Sunflower	0.55	0.41	752	1669
3.	Soybean	11.1	10.5	950	2620
4.	Safflower	0.21	0.10	457	859
5.	Sesame	1.78	0.81	456	518
6.	Castor	1.10	1.73	1568	1345
7.	Niger	0.23	0.07	310	-
8.	Linseed	0.28	0.15	539	986
9.	Rapeseed Mustard	5.79	6.31	1089	1958
	Total	**25.73**	**26.67**	**1037**	**2154**

(Sarada *et al*., 2015)

for *rabi*/summer groundnut, mustard and castor in Gujarat and Rajasthan. Almost entire safflower, sesame, niger, linseed and castor in Telangana, *kharif* sunflower in peninsular India, are grown under rainfed conditions. Thus, the production of oilseeds directly varies with the rainfall pattern (amount and distribution) during the year. Yet, oilseeds are better adapted to rainfed ecosystem than other crops. The average productivity of oilseeds in India is around 1.0 t ha^{-1}, which is far below that of the developed countries (2.5-3.0 t ha^{-1}) and of the world average (2.15 t ha^{-1}) (Sarada*et al*., 2015).

Low productivity of oilseeds is due to their cultivation under sub-optimal agro-ecologies. 64% of conditions are provided through best management practices (BMPs). Providing agro-ecological optima is the key to increased oilseeds production that is necessary for ensuring self reliance in vegetable oils on a sustainable basis.

The total factor productivity (TFP) growth rates for safflower, sesame and soybean crops are negative while it is positive for rapeseed-mustard, groundnut and sunflower crops. Within, there is large variation in TFP among different states. The level of crop diversification, development of irrigation/ input supply/ infrastructure/ marketing/ processing support, climatic aberration, etc contribute to the trends of TFP that is beyond the level of available technology

in oilseed crops. While the market forces and profitability of oilseed crops ultimately decide the acreage and level of technology adoption, it is essential to improve the efficiency of inputs used in the oilseeds production to *per se* increase in the productivity and quality besides reducing the cost, decreasing the adverse effect on environment, sustainable management of agricultural resources and soil fertility (Hegde, 2004).

There is a sharp decline in *per capita* arable land for food crops in general and oilseeds in particular. Making oilseeds production more profitable and stable can stand the competition for area expansion. Apart from cultivable land, there is general decline and shortage of resources such as soil fertility, weather and rainfall pattern, manures and fertilizers, irrigation, quality seeds, timely labour availability, effective pest control, implements, harvesting and post-harvest processing, etc. that compound the limitations for realizing higher productivity of oilseeds. The fertilizer use efficiency is declining and newer nutritive elements are becoming deficient over the decades. In addition to the pest and diseases, newer pests are emerging or minor pests are becoming major due to the change in climate pattern and reduced crop diversification. Yet newer opportunities including paddy fallow situation are opening up for crop expansion in to newer cropping systems. With minimal scope for increase in area expansion, the additional production and profitability from oilseeds must come primarily from increase in crop productivity with efficient resource use resulting in reduced cost of production and environmental safety.The global climate change is no more considered uncertain but a reality. The projected increase in the negative effects of climate change will result in greater instability in oilseed production and influence the farmers' livelihood security.Drastic changes in pest complex and intensity can occur and need preparedness through development of forecasting models.

Technological advancements have been continuously upgraded and fine-tuned through BMPs helping to operate at maximum economic yield level that also assures higher sustainability (Varaprasad, and Sudhakara Babu 2015).Delineating crop efficient zones for each oilseed crop helps in realising potential yields with limited efforts and inputs. Development of infrastructural facilities like input supply, equipment, marketing and processing will encourage adoption of this concept which results in higher oilseeds production.The yield gaps in oilseeds productivity is to the extent of 35% to 150% across nine oilseed crops that indicates the power of improved technologies in improving the productivity and profitability of oilseed crops. Besides, the technologies are sustainable over long years across wide growing conditions in farmers field.

STRATEGIES FOR INCREASING OILSEEDS PRODUCTION

The proceedings of a national brain storming session involving all stakeholders had identified the following Research, Development and Policy strategies for increasing the oilseeds production and vegetable oils availability in the country (DOR 2010).

Research

- Efforts towards developing high yielding cultivars with desirable quality parameters suitable for different agro-ecological regions and limitations, utilizing the available germplasm to be intensified.
- Integrate modern biotechnological tools such as molecular markers, marker assisted selection (MAS) and transgenic breeding supplementary to conventional breeding and adopt wherever applicable to develop cultivars with in-built resistance to biotic stresses and wide adoptability to changing climate.
- Development of diversified products from coconut kernel, tender and mature nut water, inflorescence sap, haustorium, shell and husk; Development of suitable packaging methods for market preference.
- High oil corn is a potential source of supplementary vegetable oil from maize industry but needs development of varieties of high oil yield with moderate loss of grain yield. Promote Quality protein maize (QPM) for poultry industry.
- Develop high oil yielding and gossypol free cotton varieties. Develop technology for value added products from rice bran oil such as gamma oryzanol, squaline, phytic acid, etc. that have very high export value.
- Develop small farm machinery for different operations specific to each crop to ensure timely

execution of farm operations that leads to increase in use efficiency of all other resources through improvement in yield.

- Develop machinery for precision planting, powder fertilizers spreaders, fiber scutching machine, crust breaker, oil palm harvester, safflower petal collector, etc.
- Developing value-added products from the available leads for increasing the profitability from oilseed crops.
- Technological backstopping of post harvest industries should be provided through research.
- Establishing strong linkages for successful operation of 'seed village concept' with producers, technocrats, certifying agencies for procurement and distribution can meet the local/ regional seed requirement of improved varieties in time.

Development

- Assured supply of improved quality seed.
- Increase seed replacement ratio to at least 20% for varieties and 100% for hybrids.
- Adopt location specific efficient dry farming technologies for drought proofing and sustainable oilseeds production. Integrate oilseeds production with watershed programmes for holistic development and support.
- Promote broad bed and furrow method of planting for twin benefits of moisture conservation and excess moisture disposal.
- Increase area under protective irrigation and promote efficient irrigation methods for achieving higher production and stability.
- Promote adequate and balanced fertilization with sulphur and limiting micronutrients and soil amendments.
- Effective transfer of technology with assured input, market and technological backstopping for sustained adoption. Focus on key components for intervention.
- Promote oilseeds cultivation in new and non-traditional areas and seasons for ensuring crop diversification and additional area for expansion. Ensure availability of seed and necessary inputs and agro-techniques in the new situations.
- Promote intercropping systems involving oilseeds with production technology for achieving higher efficiency of resources, profitability and risk minimization.
- Adopt need-based plant protection through effective and bio-intensive integrated pest management.
- Encourage bulk production of promising equipments by involving state governments.
- Exploit specialized niches *viz*., organic farming of sesame and niger, non-GM soybean for premium value through export and value addition, promotion of soy milk for high value.
- Exploit additional features of crops like high value safflower petals and fiber from linseed for realizing additional profits. Support by developing specific varieties and machinery/methods.
- Low productive coconut plantations due to drought and pest are to be replaced with fresh plantations with new improved hybrids, extending micro-irrigation, control of pest complex and nutrition, development of coconut based mixed farming system to efficiently utilize both below and above ground resources.
- Increasing demand for tender coconuts is limiting copra production and oil yield. Exploit Virgin Coconut Oil for its high nutritive value and profitability.
- Undertake accelerated area expansion of oil palm plantations and extend assured irrigation, power, local processing facility and competitive prices for realizing highest vegetable oil per unit area per unit time. Ensure effective transfer of technology on production and protection technologies and infrastructure for extraction and transport. Support and encourage many by-product based subsidiary occupations.
- Encourage exploitation of the realizable large potential of Tree Borne Oilseeds through organized collections, safe storage, handling and transport from the remote locations.
- Avoid use of rice bran directly as feed. Promote deoiled rice bran as feed. Realizing full potential of rice bran oil through modernizing milling plants and establishing integrated plants. Facility to separate 'rice germ' for extracting high value 'rice

germ oil' to be installed in modern mills. Popularise the use of refined rice bran oil as healthy vegetable oil for direct consumption and for blending due to its optimal mix of fatty acid composition.

- Central institute of Agricultural Engineering (CIAE) to develop a catalogue on crop specific equipments and their applicable areas with projections for scaling up. Adequate funds are to be made available through proper credit and incentives for manufacturing by small scale industries. Promote custom hiring for easy availability and use at local level especially of BBF former, seed-cum-fertilizer drill, etc.
- Avoid whole cotton seed usage as feed. Promote scientific processing of cotton seed for higher oil recovery and to get high protein retention (42%) compared to traditional processing (22%).
- Improve efficiency of extraction of oil. Prefer solvent extraction for hard seeds (<20% oil) and expeller extraction for soft seeds (35 to 40% oil).

Policy

- Decontrol of all traditional oilseeds from small scale sector to enhance efficiency in processing.
- Ensure effective market intervention to implement Minimum support price (MSP) in oilseeds.
- Encourage establishment of large scale 'captive plantations' and specialized 'seed gardens' of oil palm by declaring oil palm as a plantation. Pricing policy should consider the fair profitability from oilseeds cultivation in relation to other crops.
- Incentive for scientific processing of cotton seed for better recovery of oil.
- Regulate import of vegetable oils through application of appropriate duty structure as per the need of the country and to promote increased domestic production.
- Encourage and strengthen private participation in collaborative research, development, extension, etc. with necessary concessions.
- Ban diversion of edible oils into biodiesel production.
- Similar to sugarcane model, oil expeller industry should promote local/regional oilseeds production for assured and adequate supply raw material as per the pre-determined assured prices. The industry should involve in supporting technology development and extension activities.

SUMMARY

Oilseeds are energy rich crops, hardy and have wide adaptability to be grown under wide range of soils, climate and stresses. The low productivity of oilseeds is due to their production under sub-optimal growing conditions in rainfed marginal soils by large number of resource poor farmers. Efficient technologies are available to address each of the production limitations right from efficient agro-ecoregions, soil and moisture conservation, improved high yielding varieties and hybrids, plant population, nutrient, water, weed and plant protection management for achieving high yields. Adoption of applicable technologies can result in bridging the yield gaps and improving oilseeds production. The improved technologies are also proven to be cost effective. Thus oilseeds production can be sustained profitably at high level with reduced cost of cultivation and increased resource/input use efficiency. Future strategies to use cutting edge technologies for accelerated improvement and resource conservation are to be adopted. Newer opportunities for oilseeds cultivation through diversification of major cropping systems and extension into non-traditional areas and seasons boost oilseeds production in the country. Enabling policy support with favourable market prices and quality consciousness for driving technology adoption, participation of private investment in research and development is the need.

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INFLUENCE OF IRRIGATION LEVELS AND INTEGRATED WEED MANAGEMENT ON GROWTH AND YIELD OF AEROBIC RICE (*Oryza sativa* L.)

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ABSTRACT

The experiment was conducted to study the influence of four irrigation levels (IW/CPE ratios of 0.5, 1.0, 1.5 and 2.0) and six integrated weed management practices of application of pendimethalin/butachlor @ 1.0 kg ha^{-1} as PE fb fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS and metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} as post emergence herbicides followed by MW + HW at 45 DAS, weed free check and unweeded control on growth and yield of aerobic rice. The results revealed that higher growth parameters (plant height, tillers m^{-2} and dry matter production) at harvest and grain yield, straw yield and harvest index were recorded by irrigations given at IW/CPE ratios of 2.0 and 1.5 over other irrigation levels (0.5 & 1.0) and among weed management practices weed free check, application of pendimethalin/butachlor @1.0 kg ha^{-1} as PE fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS were the best practices and followed to this pendimethalin/butachlor @ 1.0 kg ha^{-1} applied as PE fb fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS fb MW + HW at 45 DAS recorded lower but higher than unweeded control. Combination of irrigation level at IW/CPE ratio of 2.0 along with weed free check and same level of irrigation (2.0) along with pendimethalin/butachlor @ 1.0 kg ha^{-1} applied as PE fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS fb MW + HW at 45 DAS recorded higher yields and harvest index during *kharif* 2013, 2014 and pooled mean.

Rice *(Oryza sativa* L.) is the leading cereal more than half of the world consumes as staple food. In the World, rice is grown in an area of 158.5 m ha with a production of 470.6 m t and productivity of 4.43 t ha^{-1}. China is the highest producer of rice (145.7 m t) followed by India (103.5 m t) in an area of 30.2 m ha and 43.5 m ha, respectively (USDA, 2015-16. By tradition, rice had been cultivated in flooded conditions mostly for weed management. Rice alone consumes about more than 45% of total fresh water in Asia and irrigated rice requires about 3,000-5,000 litre of water to produce 1.0 kg of grain. A new concept of growing rice termed as 'aerobic rice' involves growing rice in well-drained, non-puddled and non-saturated soils which is considered to be one of the most promising technologies in terms of water saving. The irrigation scheduling in irrigated dry aerobic rice plays major role in obtaining higher yields as well as higher water productivity. Dry tillage and absence of standing water subjected to higher weed competition it may reduce the yield 50-91 per cent. Physical, mechanical and chemical methods were effective way of weed management (Mohapatra *et al.,* 2013). In order to have optimum weed management during critical period of crop-weed competition a single weed control approach may not be able to keep weeds below the threshold level of economic damage. Therefore, should adopt the integrated weed management (IWM) which involves the selection, integration and implementation of effective weed control methods with due consideration of economics, environment and sociological consequences. So far, however, little attention has been paid to sustainable integrated weed management in aerobic rice and demands research on integrated weed management to make successful aerobic rice technology.

MATERIAL AND METHODS

The present study was conducted during *kharif* season of 2013 and 2014 at College farm, College of Agriculture, Rajendranagar, Hyderabad. The soil was clay loam in texture, neutral in reaction (pH 7.1) with high salinity (0.68 dS m^{-1}), low soil organic carbon (0.45%), low available N, medium P_2O_5 and high K_2O. The total rainfall received during *Kharif* 2013 (25th August – 29th November) was 468 mm in 31 rainy days and during *Kharif* 2014 (19th June-6th October) was 358.2 mm in 31 rainy days. The experiment consist of four irrigation levels (IW/CPE ratios of 0.5, 1.0, 1.5 and 2.0) and six IWM practices (pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE) + fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + mechanical weeding (MW) by push harrow followed by hand weeding (HW) at 45 DAS, pendimethalin @ 1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS

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+ MW fb HW at 45 DAS, butachlor @ 1.0 kg ha^{-1} as PE + fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + MW fb HW at 45 DAS, butachlor @ 1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 2.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS, weed free check (HW at 25 DAS and MW fb HW at 45 DAS) and weedy check as sub plots in split plot design and replicated thrice. Triple buffer channels were laid at width of one meter for main treatments so as to eliminate the effect of lateral seepage. Rice variety 'JGL-17004 (Prathyumna)' was sown in 15 x 10 cm spacing using 40 kg ha^{-1} seed rate and fertilized with 140 N, 60 P_2O_5 and 50 K_2O kg ha^{-1} in the form of urea, SSP and MOP respectively. Nitrogen and potassium applied in four equal splits at basal, tillering, panicle initiation and heading stages. The entire dose of phosphorus, basal doses of nitrogen and potassium, zinc sulphate and iron sulphate @ 25 kg ha^{-1} each and gypsum @ 500 kg ha^{-1} were applied basally to all the plots. For every irrigation, 40 mm depth of irrigation water (IW) was given when the Cumulative Pan Evaporation (CPE) readings reached the level of 80, 40, 26.6 and 20 mm in order to get IW/CPE ratio of 0.5, 1.0, 1.5 and 2.0, respectively. Gravimetrically soil moisture content was estimated before each irrigation in different soil depths 0-15, 15-30, 30-45 and 45-60 cm. The volume of irrigation water obtained by multiplying the depth of irrigation (40 mm) and area of the plot (5 X 4.5 m^2) and it was measured through a water meter. Pendimethalin and butachlor were sprayed as PE for total twenty four plots respectively with hand-operated knapsack sprayer using spray volume of 36 litres 24 $plots^{-1}$ (500 litres ha^{-1}). Post emergence application of fenoxyprop-p-ethyl and metsulfuron methyl + chlorimuron ethyl in respective treatments was made to one litre spray solution and sprayed by mixing with 36 litres of water per 24 plots. Hand weeding at 25 DAS in weed free check and at 45 DAS, MW and HW was done in all five treatments. Unweeded condition was maintained in unweeded control during entire crop period. Biometric observations of growth, physiological parameters, yield attributes and yield was recorded, and statistically analysed.

RESULTS AND DISCUSSION

Irrigation levels showed significant influence on growth characters with the advancement of crop growth (upto harvest) in aerobic rice. At harvest significantly taller plants, maximum number of tillers m^{-2} were recorded by scheduling irrigations at IW/CPE ratio of 2.0 and 1.5 compared to IW/CPE ratio of 1.0 and 0.5 during both years and pooled. Dry matter production (g m^{-2}) was higher with irrigation schedule of IW/CPE 2.0 and this was on par with IW/CPE ratio of 1.5. This might be due to increased frequency of irrigation led to effective uptake of water and nutrients leading to increased plant height. Low frequency of irrigation as in IW/CPE ratio at 0.5 and 1.0 recorded lower plant height, tillers m^{-2} and dry matter production in aerobic rice might be due moisture stress (Shekara *et al*., 2011). The grain and straw yield of aerobic rice was significantly influenced by irrigation schedules. Highest grain and straw yield was recorded at IW/CPE ratio of 2.0 followed by IW/CPE ratio of 1.5, 1.0 and 0.5 during both the years 2013, 2014 and pooled mean respectively. The increase in the range of 14.2, 40 and 58 per cent in grain yield, 16.5, 40 and 45.8 per cent of straw yield during 2013 and 14.9, 41.9 and 57.8 per cent of grain yield and 16.3, 40.7 and 46.4 per cent of straw yield during 2014 over IW/CPE ratios of 1.5, 1.0 and 0.5 respectively. Lesser irrigations at IW/CPE ratio of 1.0 and 0.5 reduced the yield of aerobic rice due to less availability of water for proper growth and formation of yield attributes during both the years. The harvest index was higher with IW/CPE ratio of 1.5 and was at par with 1.0 and 2.0 ratio and significantly higher than IW/CPE ratio of 0.5 during both years and pooled mean, respectively. This results supported by Narolia *et al*. (2014).

Among the IWM practices at harvest (Table 1), higher plant height, maximum number of tillers m^{-2} and dry matter production (g m^{-2}) was observed in weed free control and followed by with PE application pendimethalin @ 1.0 kg ha^{-1} + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + mechanical weeding (MW) followed by hand weeding (HW) at 45 DAS (T_2) and PE application of butachlor @ 1.0 kg ha^{-1} fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS (T_4) than other treatments during both years and pooled mean. Whereas during 2014, weed free check recorded higher dry matter accumulation followed by T_2 and it was on par with T_4. The variations in yield attributes in aerobic rice observed and inturn produced the higher grain and straw yields (Table 2) with hand weeding at 25 DAS fb mechanical weeding + hand

weeding at 45 days after sowing (T_5) and followed to this, application of pendimethalin @ 1.0 kg ha^{-1} as PE fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 days after sowing (T_2) and at par with application of butachlor @ 1.0 kg ha^{-1} as PE fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 days after sowing fb MW+ HW at 45 days after sowing (T_4) during two years of study and pooled mean. Sequential application of pre and post emergence herbicides against grasses, sedges and broad leaved weeds and integration of mechanical and hand weeding which ultimately created the favourable environment for crop growth and produced higher grain and straw yield. Weed free check showed higher harvest index (Table 2) and at par with application of pendimethalin @ 1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS (T_2) (Jadhav *et al.,* 2014 and Prameela *et al.,* 2014). Comparatively lower growth parameters, yield attributes and yields were recorded with pendimethalin @ 1.0 kg ha^{-1} as PE fb fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS fb mechanical weeding + HW at 45 DAS and butachlor @ 1.0 kg ha^{-1} as PE fb fenooxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS fb MW + HW at 45 DAS (T_3) but higher than unweeded control during both years and pooled mean respectively.

Interaction effect between irrigation levels and integrated weed management was insignificant on growth parameters and significantly influenced on grain and straw yields and harvest index during both years and pooled mean (Table 2a, b & c). Irrigation scheduled at IW/CPE ratio of 2.0 along with weed free check (I_4T_5) produced significantly higher grain, straw yield and harvest index over other combination. Followed to this, same irrigation schedule (2.0) along with pre emergence application of pendimethalin/ butachlor @ 1.0 kg ha^{-1} fb metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS fb MW + HW at 45 DAS (I_4T_2 and I_4T_4) gave higher grain, straw yield at par to each other.

Over all study, it can be concluded that higher irrigation levels (2.0 & 1.5) and among IWM practices weed free check, application of pendimethalin @ 1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS and butachlor @ 1.0 kg ha^{-1} applied as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS were produced higher growth, yields and economics. Further, the combination of higher irrigation level (2.0) along with pendimethalin/butachlor @ 1.0 kg ha^{-1} applied as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS recorded higher grain yields in aerobic rice.

Table 1. Influence of irrigation levels and integrated weed management practices on crop growth at harvest in aerobic rice during 2013, 2014 and pooled.

Treatments	Plant height (cm)			Tillers (No. m^{-2})			Dry matter production (g m^{-2})		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Irrigation levels (IW/CPE ratios)									
I_1 (IW/CPE =0.5)	67.4	66.3	66.9	182	159	170	711.5	648.1	679.8
I_2 (IW/CPE =1.0)	70.2	68.4	69.3	204	186	195	846.0	768.8	807.4
I_3 (IW/CPE =1.5)	76.5	76.3	76.4	266	251	259	1027.0	930.7	978.9
I_4 (IW/CPE =2.0)	78.1	78.0	78.0	283	268	276	1109.2	1020.8	1065.0
S.Em ±	0.9	0.6	0.7	5	5	4	49.8	27.2	35.5
CD (P=0.05)	3.1	2.0	2.5	15	18	14	172.3	94.1	122.8
CV (%)	5.1	3.5	4.2	8	10	8	25.4	15.2	18.9
Integrated weed management									
T_1	73.1	71.0	72.1	218	202	210	880.5	806.2	843.4
T_2	75.4	74.9	75.1	255	234	244	1009.5	883.4	946.4
T_3	70.7	69.1	69.9	214	196	205	855.4	810.1	832.7
T_4	73.1	73.9	73.5	248	232	240	948.4	868.7	908.6
T_5	76.1	76.5	76.3	273	262	267	1044.8	920.1	982.4
T_6	68.6	66.3	67.5	146	142	144	247.9	260.0	254.0
S.Em ±	0.8	0.9	0.8	10	9	9	11.7	9.6	8.8
CD at 5%	2.4	2.5	2.3	29	26	26	33.4	27.4	25.2
CV (%)	3.9	4.1	3.9	15	15	15	4.9	4.4	3.9

Interaction	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I	I x T	T x I
S.Em ±	1.6	1.7	1.7	1.7	1.6	1.7	20	19	18	17	18	17	23.4	54.2	19.2	32.3	17.6	39.0
CD at 5%	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S	NS	NS	NS	NS	NS	NS

T_1 - Pendimethalin @1 kg ha^{-1} as PE + fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + mechanical weeding (MW) fb hand weeding (HW) at 45 DAS
T_2 - Pendimethalin @1 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS
T_3 - Butachlor @1 kg ha^{-1} as PE + fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + MW fb HW at 45 DAS
T_4 - Butachlor @1 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS
T_5 - Weed free check (HW at 25 DAS and MW fb HW at 45 DAS, T_6 - Weedy check

Table 2. Influence of irrigation levels and integrated weed management practices on crop yield and harvest index in aerobic rice during 2013, 2014 and pooled

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index (%)		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Irrigation levels (IW/CPE ratios)									
I_1 (IW/CPE =0.5)	1137	1101	1119	2663	2526	2595	29.9	30.5	30.2
I_2 (IW/CPE =1.0)	1637	1515	1576	2950	2795	2872	35.9	35.1	35.5
I_3 (IW/CPE =1.5)	2341	2219	2280	4104	3947	4026	36.3	36.0	36.2
I_4 (IW/CPE =2.0)	2729	2607	2668	4914	4713	4814	35.9	35.8	35.8
S.Em ±	64	70	67	95	82	88	0.4	0.7	0.5
CD at 5%	221	243	231	330	285	305	1.4	2.3	1.7
CV (%)	15	17	16	12	11	11	5.2	8.3	6.4
Integrated weed management									
T_1	1846	1743	1795	3293	3148	3221	35.4	34.7	35.0
T_2	2146	2048	2097	4244	3998	4121	33.1	33.7	33.3
T_3	1771	1669	1720	3169	3009	3089	35.1	35.2	35.1
T_4	2081	1982	2032	3925	3827	3876	34.4	33.9	34.1
T_5	2292	2190	2241	4441	4318	4380	33.7	33.3	33.5
T_6	788	706	747	1711	1589	1650	29.8	29.4	29.6
S.Em ±	32	33	32	46	52	47	0.4	0.5	0.4
CD at 5%	92	96	91	133	148	134	1.1	1.4	1.2
CV (%)	6	7	6	5	5	5	3.9	5.2	4.3
Interaction	**I x T**	**I x T**	**I x T**	**I x T**	**I x T**	**I x T**	**I x T**	**I x T**	**I x T**
S.Em ±	64	67	64	93	103	94	0.8	1.0	0.8
CD at 5%	184	191	182	265	296	267	2.2	2.9	2.4
Interaction	**T x I**	**T x I**	**T x I**	**T x I**	**T x I**	**T x I**	**T x I**	**T x I**	**T x I**
S.Em ±	87	93	89	128	125	123	0.8	1.1	0.9
CD at 5%	276	298	283	407	391	389	2.4	3.5	2.8

T_1 - Pendimethalin @1.0 kg ha^{-1} as PE + fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + mechanical weeding (MW) fb hand weeding (HW) at 45 DAS

T_2 - Pendimethalin @1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS

T_3 - Butachlor @ 1.0 kg ha^{-1} as PE + Fenoxyprop-p-ethyl @ 60 g ha^{-1} at 15 DAS + MW fb HW at 45 DAS

T_4 - Butachlor @ 1.0 kg ha^{-1} as PE + metsulfuron methyl + chlorimuron ethyl @ 4.0 g ha^{-1} at 25 DAS + MW fb HW at 45 DAS

T_5 - Weed free check (HW at 25 DAS and MW fb HW at 45 DAST_6 - Weedy check

Table 2a. Interaction effect on pooled grain yield (kg ha^{-1}) of rice as influenced by irrigation levels and integrated weed management practices

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	MEAN
I_1 (IW/CPE =0.5)	1008	1292	935	1241	1450	309	1119
I_2 (IW/CPE =1.0)	1446	1748	1442	1666	1856	598	1576
I_3 (IW/CPE =1.5)	2122	2494	2087	2416	2600	894	2280
I_4 (IW/CPE =2.0)	2602	2853	2416	2803	3056	1187	2668
MEAN	1795	2097	1720	2032	2241	747	
Interaction		**I x T**	**T x I**				
S.Em ±		64	89				
CD at 5%		182	283				

Table 2b. Interaction effect on pooled straw yield (kg ha^{-1}) of rice as influenced by irrigation levels and integrated weed management practices

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	MEAN
I_1 (IW/CPE =0.5)	2419	3198	2153	2608	3266	1152	2595
I_2 (IW/CPE =1.0)	2554	3187	2536	3212	3681	1468	2872
I_3 (IW/CPE =1.5)	3625	4554	3568	4356	4894	1891	4026
I_4 (IW/CPE =2.0)	4284	5543	4100	5327	5677	2090	4814
MEAN	3220	4121	3089	3876	4380	1650	
Interaction		**I x T**	**T x I**				
S.Em ±		94	123				
CD at 5%		267	389				

Table 2c. Interaction effect on pooled harvest index (%) in rice as influenced by irrigation levels and integrated weed management practices

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	MEAN
I_1 (IW/CPE =0.5)	29.4	28.7	30.3	32.2	30.8	21.1	30.2
I_2 (IW/CPE =1.0)	36.1	35.4	36.2	34.1	33.5	29.0	35.5
I_3 (IW/CPE =1.5)	36.8	35.3	36.9	35.7	34.7	32.2	36.2
I_4 (IW/CPE =2.0)	37.8	34.0	37.1	34.5	35.0	36.3	35.8
MEAN	35.0	33.3	35.1	34.1	33.5	29.6	
Interaction			**I x T**	**T x I**			
S.Em ±			0.8	0.9			
CD at 5%			2.4	2.8			

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DISTRIBUTION OF DTPA EXTRACTABLE MICRONUTRIENTS IN SOILS OF SOUTHERN REGION OF TELANGANA STATE

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ABSTRACT

Thirty nine soil samples from ten pedons of Southern region of Telangana state were studied for vertical distribution of DTPA extractable Zn, Cu, Fe and Mn and their relationship with soil properties. Soil reaction (pH), organic carbon, calcium carbonate and particle-size fractions had strongly influence on the distribution of these micronutrients of the soil. The content of micronutrients increased with the increase in organic carbon and decreased with increase in pH and $CaCO_3$. There was a decreasing trend for the content of these micronutrients with increasing depth of the soil. As per critical limit prescribed for zinc 20 per cent of the surface soils could be rated as deficient in available zinc. Available iron, copper and manganese content of the soils were found to be adequate in the selected pedons Southern region of Telangana state.

The knowledge of vertical distribution of micronutrient cations in soils provides an idea of the inherent capacity of soils to supply the nutrients from lower horizons. Studies were conducted by different researchers (Sharma and Gupta 2001; Satyavathi and Reddy 2004; Kumar *et al.,* 2011; Thakur *et al*., 2011) to understand the content and distribution of the nutrient cations in different soils and their relationship with soil properties. However, information in this regard for the soils of Southern region of Telangana state is scanty and therefore, an attempt has been made to assess the micronutrient status in these soils and their relationship with some important soil properties.

MATERIAL AND METHODS

The study area is covered by igneous and metamorphic rocks. North western plateau and interior rugged plains form the part of Telangana state. Climatically, Southern Telangana zone falls under semi-arid (moist) tropics with an annual rainfall of around 1000 mm. The moisture regime in the study area is ustic and soil temperature class is isohyperthennic. The crops grown in the study area are rice, maize, sorghum, cotton, black gram, green gram and red gram. Horizon-wise soil samples were collected from the studied pedons. The samples were analyzed for pH, organic carbon (OC), calcium carbonate ($CaCO_3$) and particle size distribution following standard procedures. The available micronutrient cations were extracted with DTPA solution and determined with Atomic Absorption Spectrophotometer as described by Lindsay and Norvell (1978). Simple correlations were calculated between DTPA extractable micronutrient cations and soil properties.

RESULTS AND DISCUSSION

In general, the soils were neutral to alkaline and pH ranged from 6.5 to 8.9. Organic carbon content was low to medium (1.2-9.0 g kg^{-1}) and decreased with depth. Soils are calcareous and calcium carbonate content varied from 0.15 to 16.10% in different horizons (Table 1). The soils were sandy loam to clay in texture with clay content ranging from 13.9 to 48.6 %. Higher content of micronutrients were found in surface layers which might be due to their regular addition through plant residues, organic manures and fertilizers. Available micronutrients content decreased with increasing with depth of soil (Table 1).

Zinc (Zn mg kg^{-1})

DTPA-extractable zinc content in these soils varied from 0.10 to 1.90 mg kg^{-1}. About 20% of the surface soil samples could be rated as deficient in available zinc out of thirty nine soil samples from ten pedons of Southern region of Telangana state, below the critical limit of 0.6 mg kg^{-1} (Katyal, 1985). Pedon 1 and 8 are appeared to be deficient in zinc, while others of surface soils were above the critical level. Available zinc showed decreasing trend with

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increasing soil depth. Lower content of zinc in black soils is due to its fixation by clay (Manohar, 1974) or due to high pH values which have resulted in the formation of insoluble compounds of zinc (Tandon, 1995). Available Zn content was significantly and negatively correlated (r = - 0.32**) with calcium carbonate. Sand and silt contents of soil also had negative correlation but organic carbon and clay had positive correlation with DTPA extractable Zn content of the soils.

Copper (Cu mg kg^{-1})

Content of DTPA extractable copper in these soils ranged from 0.31 to 11.10 mg kg^{-1} with mean value of 1.67 mg kg^{-1}**.** Considering the critical limit of 0.2 mg kg^{-1} for Cu for normal plant growth (Katyal and Randha, 1983), the soils are rated adequate in available Cu. Soil pH and $CaCO_3$ content had negative correlation with copper but organic carbon (r = 0.32**) and clay (r = 0.39*) had significantly positive relation with Cu content (Table 2). These findings collaborates with results of Pati and Mukhopadhyay (2011); Thakur *et al*. (2011).

Iron (Fe mg kg^{-1})

DTPA extractable iron content in these soils varied between 4.50 and 48.90 mg kg^{-1}. Considering the critical limit of 4.5 mg kg^{-1} for Fe (Lindsay and Norvell, 1978), the soils are rated adequate in available Fe. Available Fe content was significantly and negatively correlated with calcium corbonate and soil reaction. These results are in agreement with findings of Satyavathi and Reddy (2004).

Manganese (Mn mg kg^{-1})

DTPA extractable manganese content of these soils varied from 2.18 and 25.18 mg kg^{-1}. Considering the critical limit of 3 mg kg^{-1} for manganese as suggested by Takkar *et al*. (1989), three pedons are deficient in Mn. Available Mn content was significantly and positively correlated with organic carbon (r = 0.30**) and clay (r = 0.36**) content of the soil (Table 2).

In general, calcium carbonate decreased the availability of micronutrients owing to formation of their insoluble hydroxides at higher pH (Sahoo *et al*., 1995). Contrary to it, organic carbon had positive influence on DTPA-micronutrients due to complexation (Thampatti and Jose, 2006).

Table 1. Soil physical and physic-chemical properties and DTPA-extractable cations of the Southern region of Telangana state

Location	Horizon	Depth (cm)	pH (1:2.5)	OC (g kg^{-1})	$CaCO_3$ (%)	Particle size distribution			Zn	Cu	Fe	Mn
						Sand	Silt	Clay				
						(%)			mg kg^{-1}			
Pedon 1: Fine-loamy, mixed, iso-hyperthermic Udic Paleustalfs												
Chevella	Ap	0-16	8.1	9.0	2.6	64.0	14.0	22.0	0.23	11.10	48.90	18.91
Dist: Ranga Reddy	Bt	16-45	8.3	6.0	2.8	60.0	10.0	30.0	0.21	10.60	30.60	12.64
	BC	45-75	8.4	4.0	3.8	66.0	10.0	24.0	0.10	8.80	28.20	10.20
	C	75-110	8.6	4.0	3.6	68.0	7.0	25.0	0.12	8.60	22.10	9.60
Pedon 2: Fine, smectitic, iso-hyperthermic Typic Haplusterts												
Rajendranagar	Ap	0-24	8.0	8.0	1.6	39.4	18.0	42.6	1.14	2.50	28.10	8.60
Dist: Ranga Reddy	Bg	24-45	8.4	7.6	1.8	41.4	10.0	48.6	0.98	1.79	9.09	7.26
	Bss_1	45-110	8.7	6.1	2.0	42.4	12.0	45.6	0.56	0.56	8.74	7.94
	Bss_2	110+	8.4	5.6	1.6	43.6	14.0	42.4	0.30	0.40	8.00	8.84
Pedon 3: Fine-loamy, mixed, iso-hyperthermic, Typic Haplustepts												
Ibrahimpatnam	A	0-15	7.1	4.2	1.8	63.1	7.1	29.8	0.96	0.38	16.84	25.18
Dist: Ranga Reddy	Bw_1	15-45	7.6	4.6	2.3	66.9	6.9	26.2	0.94	1.29	15.89	19.24
	Bw_2	45-70	8.0	3.2	3.7	67.3	6.8	25.9	0.72	0.84	15.41	16.71
	Bw_3	70-90	8.2	3.1	4.1	65.2	6.9	27.9	0.29	0.91	12.19	15.32
Pedon 4: Fine, mixed, iso-hyperthermic Typic Haplustalfs												
Thandur	Ap	0-16	8.0	7.9	0.9	56.0	12.0	32.0	1.10	0.95	13.13	6.72
Dist: Ranga Reddy	AB	16-32	8.1	5.9	0.8	55.0	11.0	34.0	1.20	0.70	13.16	5.21
	Bg	32-75	8.2	4.1	0.5	56.0	7.0	37.0	0.90	0.75	11.10	3.34
	Bt	75-110	8.2	2.9	0.1	49.0	6.0	45.0	0.66	0.43	9.80	2.18
	C	110+	8.1	2.0	0.1	52.0	12.0	36.0	0.60	0.40	8.20	2.18

Location	Horizon	Depth (cm)	pH (1:2.5)	OC (g kg^{-1})	$CaCO_3$ (%)	Particle size distribution			Zn	Cu	Fe	Mn
						Sand	Silt	Clay				
						(%)			mg kg^{-1}			
Pedon 5: Fine, mixed, iso-hyperthermic Typic Paleustalfs												
Shadnagar	Ap	0-15	6.7	2.4	0.6	77.1	8.9	13.9	1.90	0.95	28.54	6.72
Dist: Mahboobnagar	Bt	15-40	7.1	1.2	0.7	68.1	8.3	23.6	1.20	0.70	21.84	4.84
	BC	40-70+	7.2	0.9	0.9	63.0	8.6	28.3	0.66	0.53	11.80	2.70
Pedon 6: Fine, mixed, iso-hyperthermic Typic Haplustalfs												
Palem	Ap	0-18	7.0	2.1	1.4	46.5	19.5	34.0	0.98	0.79	12.50	22.60
Dist: Mahboobnagar	Bt_1	18-66	6.4	2.7	1.6	21.8	30.6	48.6	0.69	0.68	11.80	21.20
	Bt_2	66-95	7.1	2.0	1.6	29.1	28.2	42.7	0.32	0.46	9.80	18.60
	Bt_3	95+	6.8	1.9	1.6	29.3	26.4	44.3	0.26	0.44	7.20	18.20
Pedon 7: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts												
Jadcharla	Ap	0-15	6.9	3.6	1.1	66.4	7.2	26.4	1.02	0.86	10.20	19.40
Dist: Mahboobnagar	Bw_1	15-36	6.7	5.2	2.3	66.2	3.0	30.8	0.83	0.79	10.60	15.60
	Bw_2	36-90	6.8	4.8	2.6	67.4	4.0	28.6	0.49	0.42	8.20	14.80
	C	90+	6.9	4.1	2.4	66.0	3.8	30.2	0.40	0.31	7.60	12.60
Pedon 8: Fine, mixed, iso-hyperthermic Typic Calciustepts												
Suryapeta	Ap	0-12	8.1	6.2	10.6	54.0	8.0	38.0	0.58	0.76	13.80	15.20
Dist: Nalgonda	Bk_1	12-26	8.0	5.7	13.1	56.0	9.0	35.0	0.51	0.48	12.10	14.80
	Bk_2	26-50	7.8	4.2	15.4	57.0	7.0	36.0	0.32	0.41	10.40	12.60
	BC	50-100+	8.1	3.0	16.1	53.0	8.0	39.0	1.30	0.39	8.69	8.80

Location	Horizon	Depth (cm)	pH (1:2.5)	OC (g kg^{-1})	$CaCO_3$ (%)	Particle size distribution			Zn	Cu	Fe	Mn
						Sand	Silt	Clay				
						(%)			mg kg^{-1}			
Pedon 9: Fine-loamy, mixed, iso-hyperthermic Typic Haplustalfs												
Narayanapuram	Ap	0-15	6.8	8.2	1.2	65.5	12.5	22.0	0.96	1.06	7.40	19.20
Dist: Nalgonda	Bt_1	15-45	6.9	4.0	1.2	62.0	7.2	30.8	0.48	0.76	6.80	17.80
	Bt_2	45-80	7.3	3.4	1.3	40.3	7.0	42.7	0.41	0.54	5.10	12.40
	C	80-110+	7.3	2.1	2.0	52.0	8.8	39.2	1.06	0.49	4.60	12.80
Pedon 10: Fine-loamy, mixed, iso-hyperthermic Udic Ustorthents												
Gollapally	A	0-14	8.1	9.7	2.9	63.0	10.0	27.0	0.92	0.92	8.20	9.40
Dist: Nalgonda	AC	14-26	8.1	6.2	2.5	68.0	7.0	25.0	0.53	0.84	4.60	6.80
	C	26-65+	8.2	4.8	3.5	64.0	6.0	30.0	0.37	0.72	4.50	9.10

Table 2. Correlation coefficients (r) between micronutrients, physical and chemical properties of soil

	Zn	Cu	Fe	Mn
pH	-0.27	-0.37	-0.17	-0.51
OC	0.14	0.32	0.22	0.002
CaCO3	-0.32	-0.04	-0.05	-0.09
Sand	-0.14	0.21	0.25	-0.09
Silt	-0.07	0.02	0.08	0.29
Clay	0.15	0.39	0.41	0.07

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STUDIES ON CHARACTER ASSOCIATION AND PATH ANALYSIS IN RICE (*Oryza sativa* L.)

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ABSTRACT

An experiment was conducted to know the association between yield components and to assess their direct and indirect effects on grain yield in rice. The yield components such as number of productive tillers per plant and number of filled grains per panicle were found to be very crucial for high yields, as they exhibited significant positive correlations with grain yield per plant. The other important traits to be considered are plant height and panicle length. Generally, in rice, semi tall plant types (110-115 cm) with sturdy culm (non- lodging) would yield better than the dwarf ones. Path coefficient analysis revealed that number of filled grains per panicle exerted highest positive direct effect on grain yield followed by number of productive tillers per plant, 1000 grain weight, spikelet fertility (%) and days to 50% flowering at both phenotypic and genotypic level. Number of productive tillers per plant had positive indirect effects through all the yield components except 1000 grain weight.

Rice is an important staple food crop feeding more than half of the world's population. To improve yield, evaluation of germplasm is the most important aspect (Yadav, 2000) because yield as such is controlled by a large number of characters. Development of high yielding varieties requires a thorough understanding of existing genetic variability as well as magnitude and direction of genetic association among the yield contributing characters. The most important criteria in any crop improvement programme are the selection of genotypes with all possible desirable yield contributing traits. Information on association of characters, direct and indirect effects contributed by each character towards grain yield will be an added advantage in selection process. Correlation and path analysis establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield. In view of the above the present investigation was carried out with the objective of studying the character association, direct and indirect effects in rice hybrids for yield improvement.

MATERIAL AND METHODS

The material for the present study consists of 79 rice genotypes (includes 60 hybrids, 17 parents and two checks). The experiment was conducted during *kharif*, 2014 in Randomized Block Design with three replications at Seed Research & Technology Centre, Rajendranagar, Hyderabad. Each entry was planted in two rows of 5 meter length with a spacing of 15 x 15 cm. Recommended package of practices were followed to raise the healthy crop. Data was collected from ten randomly selected plants from each entry. Observations were recorded for eight traits *viz*., days to 50% flowering, plant height (cm), number of productive tillers per plant, panicle length (cm), number of filled grains per panicle, 1000 grain weight (g), spikelet fertility (%) and grain yieldper plant (g). Pooled data was used to estimate the simple correlations (Snedecor and Cochran, 1967) and path analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

The analysis of variance for eight traits revealed the existence of highly significant differences among the genotypes (Table-1).This indicated the presence of sufficient variation among the genotypes for the traits studied. Studies on character association, to assess the relationship among yield and its components presented in (Table-2). The grain yield per plant had significant positive association with plant height, number of productive tillers per plant, panicle length, number of filled grains per panicle and spikelet fertility (%). Similar kind of observation was reported by Selvaraj

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et al. (2011) and Rafii *et al.* (2014) for plant height; Bhadru *et al.* (2012) and Ravindra Babu *et al*. (2012) for number of productive tillers per plant; Gulzar *et al.* (2012) for number of filled grains per panicle. The character days to 50 % flowering expressed significant positive association with plant height and number of filled grains per panicle. Increased flowering duration resulted in increase of panicle length and number of filled grains per panicle, which in turn helped to realize higher grain yield per plant.

Positive significant correlation was observed for plant height with panicle length, number of productive tillers per plant and also with grain yield per plant. It indicated that plant height plays important role in enhancement of yield potential in rice. Thus, breeding for semi tall varieties with sturdy culm rather than dwarf varieties would be a perspective approach. The trait, number of productive tillers per plant exhibited significant positive association with panicle length, number of filled grains per panicle and grain yield per plant.

Panicle length showed significant positive correlation with number of filled grains per panicle, spikelet fertility (%) and grain yield per plant as reported by Rajamadhan *et al.* (2011) and Bhadru *et al.*(2012). The trait number of filled grains per panicle is considered as an important component for realizing high yield, because it exhibited significant and positive association with days to 50% flowering, plant height, number of productive tillers per plant and panicle length. Spikelet fertility (%) expressed positive relationship with panicle length and number of filled grains per panicle.

Estimates of direct and indirect effects on yield attributing traits over locations are presented in (Table-3). Days to 50% flowering had positive direct effect on grain yield at both phenotypic (0.0795) and genotypic levels (0.0386). Plant height had positive direct effect on grain yield as was reported by Pandey *et al*. (2012) and Yadav *et al*. (2012). The indirect effect of this trait on grain yield through number of productive tillers per plant, panicle length and number of filled grains per panicle at genotypic level were also positive. Number of productive tillers per plant exhibited positive direct effect (0.3246 and 0.5672 at phenotypic and genotypic level respectively) on grain yield per plant. Similar results were reported by Ravindra Babu *et al*. (2012) and Thirumala Rao *et al*. (2014). It is interesting to note that productive tillers had positive indirect effects through all the other yield components except 1000 grain weight.

Positive direct effect was exerted by number of filled grains per panicle on grain yield per plant at both phenotypic (0.6748) and genotypic (0.5926) level which indicated its greater role in higher yield. Seyoum *et al.* (2012), Tirumala Rao *et al*. (2014) and Venkanna *et al.*(2014) also reported that productive tillers were very important among yield components. Another important yield contributing trait is spikelet fertility (%), as evident from positive direct effect of 0.0772 and 0.1528 on grain yield at phenotypic and genotypic level respectively. The trait, 1000 grain weight exerted positive direct effect (0.3017 and 0.3332) at phenotypic and genotypic level on grain yield per plant. Indirect positive influence of 1000 grain weight on grain yield was observed through panicle length (Ravindra Babu *et al.*, 2012 and Tirumala Rao *et al.*, 2014).

A critical analysis of both character association and path analysis indicated that among the yield components investigated, number of productive tillers per plant and number of filled grains per panicle were determined as most critical ones as both the correlation coefficients as well the direct effects were high with grain yield per plant. Other important traits for high grain yield were panicle length, spikelet fertility per cent and 1000 grain weight.

Table 1. Pooled analysis of variance for yield and yield components in rice

Source of variation	df	Days to 50% flowering	Plant height plant^{-1}	No. of productive tillers	Panicle length panicle^{-1}	No. of filled grains	Spikelet fertility (%)	1000 grain weight	Grain yield plant^{-1}
Replications	2	14.49 **	4455.71 **	85.26 **	170.52 **	8302.71 **	263.06 **	0.55 *	2297.39 **
Treatments	78	87.41 **	240.82 **	6.34 **	8.24 **	4039.24 **	26.58 **	28.58 **	147.12 **
Error	156	2.91	72.76	1.71	2.12	259.98	3.26	0.13	19.98
Total	236	30.94	165.45	3.95	5.57	1577.22	13.17	9.54	81.30

* Significant at 5 % level ** significant at 1 % level

Table 2. Simple correlation coefficients for grain yield and its yield components traits in rice

Characters	Days to 50% flowering	Plant height	No. of productive tillers plant^{-1}	Panicle length	No. of filled grains panicle^{-1}	Spikelet fertility (%)	Test weight	Grain yield plant^{-1}
Days to 50% flowering	1.0000	0.4269 **	0.1245	0.0716	0.3530 **	-0.1068	-0.5610 **	0.1921
Plant height		1.0000	0.1138	0.3605 **	0.3270 **	-0.0325	-0.1418	0.2722 *
No. of productive tillers / plant			1.0000	0.5011 **	0.4505 **	0.1846	-0.0948	0.6824 **
Panicle length (cm)				1.0000	0.4748 **	0.2496 *	0.071	0.5468 **
No. of filled grains / panicle					1.0000	0.2729 *	-0.4103 **	0.7544 **
Spikelet fertility (%)						1.0000	0.2184	0.4041 **
Test weight							1.0000	-0.0146

*Significant at 5% level **Significant at 1% level

Table 3. Genotypic (G) and phenotypic (P) path coefficients for grain yield and yield contributing characters in rice

Characters		Days to 50% flowering	Plant height	No. of productive tillers / plant	Panicle length	No. of filled grains / panicle	Spikelet fertility (%)	Test weight	Grain yield / plant
Days to 50% flowering	P	0.0795	0.0280	0.0063	0.0029	0.0258	-0.0063	-0.0429	0.1512
	G	**0.0386**	0.0193	0.0062	0.0039	0.0143	-0.0048	-0.0221	0.2187
Plant height	P	-0.0045	-0.0129	-0.0016	-0.0029	-0.0033	0.0002	0.0015	0.1901
	G	0.0978	**0.1957**	0.0207	0.0996	0.0776	-0.0098	-0.0328	0.3510
No. of productive tillers / plant	P	0.0257	0.0395	0.3246	0.1336	0.1221	0.0485	-0.0238	0.5725
	G	0.0918	0.06	**0.5672**	0.3365	0.2935	0.1227	-0.0644	0.7846
Panicle length	P	0.0001	0.0003	0.0006	0.0015	0.0006	0.0003	0.0001	0.4248
	G	-0.0189	-0.0956	-0.1115	**-0.1879**	-0.1035	-0.0593	-0.016	0.6551
No. of filled grains / panicle	P	0.2191	0.1707	0.2539	0.2607	0.6748	0.1594	-0.2604	0.7207
	G	0.219	0.235	0.3066	0.3266	**0.5926**	0.1763	-0.2515	0.7785
Spikelet fertility (%)	P	-0.0058	-0.0010	0.0108	0.0126	0.0171	0.0722	0.0139	0.3322
	G	-0.0189	-0.0076	0.033	0.0482	0.0454	**0.1528**	0.0359	0.4562
Test weight	P	-0.1629	-0.0345	-0.0221	0.0165	-0.1164	0.0580	0.3017	-0.0099
	G	-0.1907	-0.0559	-0.0378	0.0283	-0.1414	0.0783	**0.3332**	-0.0176

Bold values are direct effects

Phenotypic residual effect = **0.5447** Genotypic residual effect = **0.2753**

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IMPACT OF DAIRY MANAGEMENT PRACTICES ADOPTED BY WOMEN DAIRY FARMERS ON QUALITY OF MILK AT SOCIETY LEVEL

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ABSTRACT

The study was conducted to assess the impact of dairy management practices on the quality of milk at production levels (societies) in the Karimnagar district of Telangana state. A total of 2850 women dairy farmers were interviewed for the questionnaire prepared. As per the studies the farm women from member and non member group not following the ideal management practices such as housing management (57.35&88.0%),cleaning of animal shed/shelter before milking (34.50&38.89%),washing of animals before milking (82.25&93.80%),washing of milkers hand before milking (43.30&33.96%),washing of udder at the time of milking (20.60&34.45%),wiping of udder with clean dry cloth before milking, dipping of teats in disinfectant solution (99%),cleaning and drying of utensils (30.0&22.56%) and 62&81.50% of the respondent do not have the knowledge about mastitis, hence the management practices showed clear impact on quality of milk. The time taken for reduction of methylene blue was 3.98 &5.13 hrs. standard plate count and e.coli 32.64 ±1.55, 36.52± 5.94,33.44±1.47&,35.58± 0.18 respectively in member and nonmember groups which was below in compared with BIS standards and the over all quality is graded as fair

In animal husbandry, women have multiple roles. Their activities vary widely ranging from care of animals, grass cutting, fodder collection, cleaning of animal sheds to processing of milk into products. Rural women were found to devote 90 percent of labour force in livestock farming. About 75 million women as against 15 million men are engaged in dairying in India. The management practice and maintenance of udder health, cleanliness of animal, milker and utensils reflects the quality of milk and milk products. The self life and quality of milk depends upon the producers, health of the animal, health of the udder, health of the milker, milk pails and management practices adopted in the farm.

Milk is an excellent growth medium of micro organism if it is produced unhygienic and handled improperly. Hence an attempt was made to collect the information on management practices adopted by farm women in relation to quality of milk, which will be use full for the implementation of dairy husbandry practices for quality milk production.

MATERIAL AND METHODS

The data was collected from 2000 members and 850 nonmembers from milk shed area of Mulukanoor Women Dairy Cooperative Society randomly by using pretested interview schedule. The data collected from interviewed respondents was coded, classified and analyzed in order to make the findings meaningful. Milk samples for analysis were collected randomly from member and nonmember and subjected to analysis of fat (IS: 1224 (Part I)1997, SNF (IS: 1224-1958), microbial test viz. MBRT, SPC and E.Coli (IS: 1479 (Part III) 1962) in the laboratory and compared with Bureau of Indian Standards. The mean and standard deviation were calculated as per the standard procedures of Snedecor and Cochran (2004). The data was also subjected to analysis for interpretation in terms of frequency distribution and percentage.

RESULTS AND DISCUSSION

The results from the studies revealed that, 57 and 88 percent of the farmers are providing shelter to their animals besides their houses with minimum protection and 36.70 & 8.94 percent farmers providing pucca house, whereas 6 & 3.05 percent of the farmers are not providing any shelter in member and non member group respectively. These results are in agreement with the results of Divakar *et.al*. (2010), Bainwad *et.al*. (2007) and Sarwiyono *et.al*.(1993).

Regarding cleaning of animal shed/shelter before milking more than 50 percent women farmers (62.10& 54.91) practicing, whereas 34.50 and 38.60 percent of women farmers not practicing this activity and 3.4 & 6.5 percent of the women farmers do not know about this activity both in member and non member groups. Similarly majority (82.25&93.80) of

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the women farmers were not washing their animals before milking and very few (8.45&3.25) of them adopted this practice, whereas 9.30&2.95 percent farmers not known about this activity. 56.70 and 66.04 percent of the women farmers washing their hands at the time of milking and 43.30 and 33.96 percent not washing their hands at the time of milking in member and nonmember group.

In respect of udder health maintenance 65-80 percent women farmers washing the udder at the time of milking, whereas 20.60 and 34.45 percent not practicing in member and non member group respectively. Similarly more than 96 percent of the women farmers in member and non member groups are not practicing the wiping of udder with dry cloth and about 4.15 and 2.72 percent of the women farmers do not know the wiping of udder before milking. Regarding dipping of teats in disinfectant solution 98.68 and 97.15 percent women farmers do not having the knowledge whereas 1.32 and 2.85 percent women farmers practicing this activity in member and non member group respectively. Similarly Asaminew Tassew and Eyassu Seifu (2011) reported that the milk produced by the farmers and dairy cooperatives was poor due to scrupulous hygienic measures during production and handling of milk.

Cleaning of utensils more than 70 percent of the women farmers cleaning and drying their milking pails in member and non member group whereas 30 percent in member and 22.56 percent in non member group not practicing this activity and 9.0 percent of the farmers revealed that they do not know.

To assess the impact of udder health, the knowledge about mastitis in member and non member groups was studied and 41.38 percent of the women farmers having the knowledge about mastitis in member group and only 18.5 percent women farmers in non member group, whereas 58.62 percent in member and81.50 percent in non member group does not have the knowledge about mastitis. Similarly Syed A.M *et al*. (2009) reported that inflammation of udder with high somatic cell count under poor management practices. Mohi *et al*. (2006) reported that majority of the members of Punjab dairy farmers association who adopted ideal feeding, health and breeding management practices, had achieved the higher productivity and net returns.

This warrants us, the need for educating the women dairy farmers regarding the importance of ideal management practices in improving the productivity of animals by organizing campaigns and training programmes. Although the women dairy cooperative society is doing it well, it is insufficient from the farmers perceptional point of view also.

Quality of Milk at Society Level

To study the quality of milk, milk samples from member and non member of women dairy cooperative societies prior to collection was collected randomly and subjected various quality assessment test. Table 2. revealed that the mean values of fat (%), SNF (%) and temperature (^{o}C) of raw milk was 6.66 ± 0.13, 8.83 ± 0.04 and 27.50 ± 0.38 and 5.81 ± 0.18, 9.02 ± 0.03 and 28.62 ± 0.185 in member and non member group respectively. This shows that the milk from non member is in low quality in terms level of fat% and increased temperature. These findings are in support with the reports of Reddy *et al*. (2000).

Similarly the microbial quality of raw milk in non member group was poor. The Standard Plate Count, E. Coli, MBRT and acidity tests of raw milk showed that there was early reduction of methylene blue (3.98 hr.) with the SPC, E. Coli and acidity levels of 32.64 ± 1.55 lakhs cfu/ml, 33.44 ± 1.47 lakh cfu/ml, and 0.138 ± 0.002 in member group, whereas MBRT was taken longer time (5.13hr.) and more number of counts for SPC and E.Coli (36.52± 5.94&35.58± 6.49 cfu/ml) with increased acidity (0.140±0.002) in non member group. Lingathurai and Vellathurai (2010) was observed that the total plate count and E. Coli contamination was higher in raw cow milk. Similarly Grimaud *et al*. (2007) also reported similar findings about microbial quality of farm level milk.

The higher percentage of fat and SNF at society level was might be attributed to the more buffalo milk production within the study area. The temperature of milk at society level was indicating that fresh milk before subjected to cooling had recorded high temperature. Similarly MBRT, SPC and E.coli count for milk from member and non member was graded as good and 'fair' quality respectively. Kashifa. M *et al*. (2001) revealed that the MBRT of studied sample was fair and over all hygienic quality

of milk was very poor. It shows that there is high level of contamination of milk at milking, either from animals or milker, or from the milking pail with poor management practices. This is clearly indicating that the dairy farm women need the education and trainings in steps involved in clean milk production to produce the quality milk and reduce the contamination. Chatterjee *et al*. (2006) also reported that the microbial colonies were low in pasteurized milk and quality was found to excellent out of ten samples and raw milk showed poor quality parameters.

Table 1. Management practices adopted by member and non member groups

S.No.	Management practices	Response	Number responded (n=2000)	Percentage	Number responded (n=850)	Percentage
1	Housing management	Practiced	1147	57.35	748	88.0
		Not practiced	734	36.70	76	8.94
		Not known	119	5.95	26	3.05
2	Cleaning of animal shed/shelter before milking	Practiced	1770	62.10	1565	54.91
		Not practiced	983	34.50	1100	38.59
		Not known	97	3.40	185	6.50
3	Washing of animals before milking	Practiced	241	8.45	93	3.25
		Not practiced	2344	82.25	2673	93.80
		Not known	265	9.30	84	2.95
4	Washing of milkers hand before milking	Practiced	1616	56.70	1882	66.04
		Not practiced	1234	43.30	968	33.96
		Not known	0	0	0	0
5	Washing of Udder at the time of milking	Practiced	2263	79.40	1868	65.55
		Not practiced	587	20.60	982	34.45
		Not known	0	0	0	0
6	Wiping of udder with clean dry cloth before milking	Practiced	0	0	0	0
		Not practiced	2732	95.85	2772	97.28
		Not known	118	4.15	78	2.72
7	Dipping of teats in disinfectant solution	Practiced	38	1.32	81	2.85
		Not practiced	2812	98.68	2769	97.15
8	Cleaning and drying of utensils	Practiced	1995	70.00	1950	68.44
		Not practiced	855	30.00	643	22.56
		Not known	0	0	257	9.00
9	Knowledge about mastitis	Known	1180	41.38	527	18.50
		Not known	1670	58.62	2323	81.50

Table 2. Quality of milk at member and non member groups prior to collection

S. No.	Observed variables	Member group		Non member group	
		Mean	S.E	Mean	S.E
1	Fat (%)	6.66	0.13	5.81	0.184
2	SNF (%)	8.83	0.04	9.02	0.085
3	Temperature (°C)	27.5	0.38	28.62	0.185
4	Acidity	0.138	0.002	0.140	0.002
5	SPC (Lakh) (Grade)	32.64 (Fair)	1.55	36.62 (Fair)	5.94
6	*E. coli* (Lakh) (Grade)	33.44 (Fair)	1.47	35.58 (Fair)	6.49
7	MBRT (hr.) (Grade)	3.98 (Good)	0.32	5.13 (Good)	0.18

CONCLUSION

The farmers of the member and non member group could not follow ideal management practices. It shows that there is high level of contamination of milk at milking, either from animals or milker, or from the milking pail with poor management practices This warrants us, the need for educating the women dairy farmers regarding the importance of ideal management practices in improving the productivity of animals and quality products by organizing campaigns and training programmes. Although the women dairy cooperative society is doing it well it is insufficient from the farmers perceptional point of view also.

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GENETIC ANALYSIS OF PRE-WEANING GROWTH PERFORMANCE IN DECCANI SHEEP

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ABSTRACT

The present investigation was undertaken to study the effect of genetic and various non-genetic factors affecting the pre-weaning growth traits in Deccani flock of 300 animals maintained at Livestock Research Station, Mahabubnagar, Telangana State from October, 2012 to July, 2015. The least squares means for body weights at birth, 15, 30, 45, 60, 75 and 90 days of age were 2.72 ± 0.03, 4.37 ± 0.07, 5.90 ± 0.10, 7.49 ± 0.12, 9.03 ± 0.14, 10.32 ± 0.15 and 11.48 ± 0.16 kg, respectively.. The analysis of variance revealed significant influence of sex on birth weight (P≤0.05); season on 90 days weight at (P≤0.01) and parity of ewe on body weights at 30, 45 and 60 days age (P≤0.05). The effect of weight of dam was non-significant on all the pre-weaning body weights.

Deccani is a versatile sheep breed of Deccan plateau with medium-body frame and ranging in colour from predominantly black or black with white markings. The breed is hardy and well-suited to extreme climatic conditions of the Deccan peninsula and has been traditionally reared by pastoral communities of Kurmas and Gollas in Telangana. Inadequate availability and poor quality of feed and fodder; high incidence of diseases; and inadequate knowledge on appropriate management of livestock were identified as the major contributory factors for the low productivity of this breed. Lack of adequate efforts in selective breeding, and use of poor quality breeding rams, closed herds and indiscriminate mating with adjacent local non-descript sheep are the major causes for the dilution of this breed. Growth rates are good indicators of adaptability of an animal to the existing environmental conditions and essential for production, reproduction and survivability. Fast growth rates ultimately determine their meat producing capability up to marketing age hence used as criteria of selection.

They are largely affected by both genetic and non genetic factors. Hence, the present study was conducted to investigate the pre- weaning growth performance in Deccani sheep.

MATERIAL AND METHODS

A total of 300 lambs born to fifteen sires at Livestock Research Station, Mahabubnagar, Telangana State from October, 2012 to July, 2015 were used for studying pre weaning body weights. All the lambs were raised under similar regime of feeding, shelter (housed in sheds with mud floor and asbestos sheet roof). Eight hours of grazing and concentrate mixture (CP 18%) of 300 gm per animal was provided during the entire experimental period.Body weights at birth(BW0), 15(BW15), 30(BW30),45(BW45, 60(BW60),75(BW75) and 90(BW90) days of age were recorded. All the experimental lambs were weighed at the time of birth and at fortnightly intervals up to three months (90 days) of age with the digital balance of 50 gm accuracy. The data was subjected to least squares analysis (Harvey, 1966) and the means were compared by Duncan's multiple range test (DMRT) to study the influence of various genetic and non genetic factors such as season of birth (two seasons; January to June and July to December), sex of the lamb(male and female), ewe weight at lambing(,<25 kg ,25to 30 kg and < 30 kg) and parity of the ewe at lambing(1,2,3 and 4 th).

RESULTS AND DISCUSSION

The overall least squares means (Table.2) obtained in the present study were 2.72 ± 0.03, 4.37 ± 0.07, 5.90 ± 0.10, 7.49 ± 0.12, 9.03 ± 0.14, 10.32 ± 0.15 and 11.48 ± 0.16 kg at birth, 15, 30, 45, 60, 75 and 90 days of age, respectively. These findings are in contrary to the earlier findings of Mane *et al.* (2014) Annual Report, ICAR (2009-10 and 2010–11) Chikurdekar *et al.* (2012) in different herds of Deccani who reported slightly higher body weights in all ages

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studied. Body weights ranged from 2.87 ± 0.01 to 3.44 ± 0.01 at birth and 13.86± 0.09 to 16.40±0.23 kg at 90days age.

These differences in pre weaning weights might be due to differences in mothering abilities of dams, herd ,sire and seasonal differences in different regions of the country.

Several research findings in other sheep breeds such as Malpura, Gowane *et al.,* (2010 and 2015); Arora *et al.,* (2014) and Kumar *et al.,* (2008) , in Marwari, Nirban *et al.* (2015) and Singh *et al.* (2013), in Muzaffarnagari Dass.*et al.* (2012, 2014) and in Magra, Vivekanand et *al.* (2014) reported higher body weights in all ages compared to Deccani . The body weights ranged from 2.64 to 3.65 at birth and 13.09 to 15.13 at 90 days age across the breeds depending on the size of the breed and due to breed differences.

Ganesan *et al*. (2015) andBalasubramanyam *et al.*(2012 and 2010) in Madras red reported that the body weight at birth and 90 days ranged from 2.67 to 2.82 and 9.40 to 10.96 kg. Similar studies by Karunanithi *et al.* (2011) in Mecheri sheep showed a birth weight of 2.82 ± 0.01kg and 90 days 10.9 ± 0.1 while the Nehra *et al.* (2006) in Marwari sheep breed reported a birth weight of 2.77 ± 0.04 and 90days 11.78 ± 0.20 kg which are nearer to Deccani breed.

Significant influence of sex was observed only on birth weight (P≤0.05).these findings are in agreement with the reports of Ganesan *et al.* (2015) and Balasubramanyam *et al.* (2012 and 2010) in Madras Red sheep. However, sex affected significantly the body weight at birth and other pre-weaning ages in Malpura by (Gowane *et al.,* 2010); Marwari by (Nirban *et al.,* 2015 and Singh *et al.,* 2013); Nali by (Albial *et al*., (2014); Muzaffarnagari by (Dass *et al.,* 2014) Deccani by (Mane *et al.,* 2014 and Chikurdekar *et al.,* 2012) and in Magra sheep by (Vivekanand *et al.,* 2014). Male lambs were significantly heavier (2.78 ± 0.04 kg) than female lambs (2.67 ± 0.04 kg) at birth and this superiority of males continued throughout the pre-weaning period though non-significantly and similar findings were also reported in different sheep breeds by Nirban *et al.* (2015) in Marwari and Albial *et al*. (2014) in Nali breed.

Season of lambing had significant influence only on body weight at 90 days (P≤0.01) and not on other pre weaning body weights. However the published literature revealed significant effect of season of birth on all pre-weaning body weights in several other sheep breeds (Ganesan .*et al.,* 2015; Balasubramanyam .*et al.,* 2012 and 2010 in Madras red; Albial .*et al*., 2014 in Nali; Mane *et al.,* 2014; Chikurdekar *et al.,* 2012 in Deccani and Chopra *et al.,* 2010 in Bharat merino sheep). Lambs born during minor season (Summer) were attained higher body weight than those born during major season (winter) at 45, 60, 75 and 90 days of age except birth weight. These findings are in accordance with the research findings of Nehra *et al.* (2006) in Marwari and Mane *et al.* (2014) in Deccani sheep breed. Adequate nutrition during the summer months by providing additional feed and fodder and reduced movement due to few hours of grazing in summer might be the reason for attaining higher body weight in summer season than winter season.

Ganesan *et al.* (2015) in Madras red, (Nirban *et al.,* 2015, Singh *et al.* 2013 and Nehra *et al.,* 2006) in Marwari and Chopra *et al.* (2010) in Bharat Merino breed reported that the dam weight affected the all pre weaning body weights, Contrary to their findings the present study revealed a non-significant effect of dam on all pre-weaning body weights. The pre weaning body weights are influenced by sex of lamb, season of lambing, parity of dam, milk yield of dam, dam breed component, sire breed component and their interaction, nursing ability of dam and lamb-dam association during this pre weaning and suckling period. Non influence of dam weight might be due to a lesser nursing ability of dam, sire component of additive genetic variance contributed more than dam for body weights.

Lambs born during third parity had significantly (P≤0.05) higher body weights at 30, 45 and 60 (Table.1) days age (6.10 ± 0.13, 7.76 ± 0.15 and 9.34 ± 0.18 kg) followed by fourth, second and first parity ewes. These findings are in agreement with reports of Albial *et al*. (2014) in Nali and Vivekananda *et al.* (2014) in Nali and Magra wherein the parity of ewe significantly affected all the pre-weaning body weights. However, Nirban *et al.* (2015) and Singh *et al.* (2013) in Marwari sheep breed reported significant effect of parity on only birth weight. It might be due to more milk production due to increase in udder size as parity order advances the higher order parity ewes born lambs have weights in increasing trends as the parity order increased.

Table. 1. ANOVA for pre-weaning body weights in Deccani lambs

Source	df	BW0		BW15		BW30		BW45		BW60		BW75		BW 90	
		MS	F	MS	F	MS	F	MS	F	MS	F	MS	F	MS	F
Sex	1	0.87	6.18 *	2.03	2.94	0.00	0.00	0.77	0.39	0.12	0.05	0.26	0.08	2.85	0.83
Season	1	0.27	1.95	1.94	2.80	4.52	2.96	0.01	0.00	6.18	2.26	7.06	2.16	28.28	8.22 **
Ewe Weight	2	0.11	0.76	0.02	0.02	0.55	0.36	1.63	0.82	1.69	0.62	0.71	0.22	0.80	0.23
Parity	3	0.38	2.73	1.44	2.09	4.44	2.91 *	5.38	2.72 *	7.66	2.80 *	4.11	1.26	3.84	1.12
Error	293	0.14		0.69		1.53		1.98		2.74		3.27		3.44	

* Significant (P≤0.05); ** Significant (P≤0.01)

Table. 2. Least squares means for pre-weaning body weights in Deccani lambs

Effect	BW0		BW15		BW30		BW45		BW60		BW75		BW90	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Overall	2.72	0.03	4.37	0.07	5.90	0.10	7.49	0.12	9.03	0.14	10.32	0.15	11.48	0.16
Sex														
Male	2.78[a]	0.04	4.45	0.08	5.90	0.13	7.54	0.14	9.05	0.17	10.35	0.18	11.57	0.19
Female	2.67[b]	0.04	4.28	0.09	5.90	0.13	7.44	0.15	9.01	0.17	10.29	0.19	11.38	0.19
Season														
Jan. to June	2.69	0.04	4.28	0.10	5.77	0.14	7.50	0.16	9.18	0.19	10.48	0.21	11.80[a]	0.21
July to Dec.	2.76	0.03	4.45	0.08	6.03	0.11	7.48	0.13	8.88	0.15	10.16	0.16	11.16[b]	0.17
Ewe Weight														
<25 kg.	2.69	0.03	4.38	0.08	5.99	0.11	7.62	0.13	9.16	0.15	10.41	0.17	11.54	0.17
25 to 30kg	2.74	0.04	4.35	0.08	5.93	0.12	7.59	0.13	9.14	0.16	10.26	0.17	11.39	0.18
>30 kg.	2.74	0.07	4.37	0.16	5.77	0.24	7.25	0.27	8.78	0.32	10.29	0.35	11.50	0.36
Parity														
1	2.62	0.04	4.18	0.10	5.60[b]	0.15	7.21[b]	0.17	8.65[b]	0.20	10.03	0.21	11.17	0.22
2	2.72	0.05	4.32	0.11	5.86[ab]	0.16	7.39[ab]	0.18	8.98[ab]	0.21	10.32	0.23	11.51	0.24
3	2.72	0.04	4.43	0.09	6.10[a]	0.13	7.76[a]	0.15	9.34[a]	0.18	10.53	0.19	11.63	0.20
4	2.83	0.07	4.53	0.16	6.04[ab]	0.24	7.60[ab]	0.28	9.14[ab]	0.32	10.40	0.35	11.59	0.36

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A STUDY ON PRODUCTION PROFILE IN QUAILS FED WITH PROBIOTICS

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ABSTRACT

The objective of this study was to investigate the effect of supplementation of Dietary baker's *yeast* as a probiotic on body performance of Japanese quails (*Coturnix* coturnix japonica). In this experiment a total of 96 day-old unsexed, growing Japanese quails were equally divided into three groups of 32 birds in each group. The experiment was terminated when birds were 6 weeks old. The standard basal diet was fed in first group (G1), 5% and 10% level of baker's yeast was supplemented in basal diet for second group (G2) and third group (G3) respectively. Feed and water was supplied *ad libitum* for all the birds. Body performance was determined by measuring feed intake, body weight gain and feed conversion ration. The results obtained in this study showed that, supplementation of dietary baker's yeast had positive effect on production performance in Japanese quails

Japanese quails (*Coturnix* coturnix japonica) have become an important live stock because it has a small body size, easy to handled, large number of birds can be kept in a limited space, high egg production, many offspring can be available from certain number of parents. It is also used in embryological studies (Ayasan and Okan, 2001). Quail eggs are rich in protein and good source of iron, phosphorus, riboflavin, and selenium (Bing, 2011).

Probiotics are live microorganisms which are mainly derived from certain bacteria, fungi and *yeast* cell. Yeast (*Saccharomyces cervisiae*) is one of the most widely used probiotics. It has been fed to animals and poultry. *Yeast* is a 'single cell protein' the production is originated in Germany during World War – I, when the baker's *yeast*, was grown with molasses as the carbon, energy and nitrogen source for consumption as a protein supplement.

It is known that, Mannan oligosaccharide and Fructo-oligosaccharides are derived from cell wall of *yeast* and shown in suppressing enteric pathogens and modulating the immune system in poultry (santin *et al.,* 2001; Spring *et al*., 2000; lji *et al*., 2001). These properties led researchers to use *yeast* culture as probiotic feed additives in Japanese quails diet.

There was a limited number of studies reported on effect of dietary *yeast* on performance and blood biochemical profile in Japanese quails. Therefore, the present study was conducted to investigate the effect of supplementation of dietary baker's *yeast* as a probiotic on body performance and blood biochemical profile of Japanese quails

MATERIAL AND METHODS

In this study, a total of 96 laying Japanese quails aged 25 weeks were randomly assigned to 12 cages of 8 birds each and cages were allocated to three groups with four replication per treatment. The birds were housed in standard cages (40x40x25 cm^3) in a temperature controlled house at 73^0 F. All the birds had free access to feed and water. The photoperiod was 16 hrs (Vatsalya and Kashmiri, 2011). Prior to the supplementation of yeast in the experimental diets, all the birds were fed *ad libitum* for 7 days for acclimatization. The birds of three groups were fed with experimental diets as follows, In the first group (G_1) was fed with control/basal diet (Table 1), in the second group (G_2) was fed with 5% level of baker's *yeast* in the basal diet and in the third group (G_3) was fed with 10% level of baker's *yeast* in the basal diet. The experimental period lasted for 6 weeks.

The body weight (g/bird), body weight gain (g/bird) and feed intake (g) of birds per replicate were recorded on individual basis at weekly intervals and average values were recorded. Feed conversion ratio (FCR) was also calculated weekly. FCR was calculated by dividing the feed intake by body weight gain (Quigley *et al*., 1997).

Data were statistically analyzed using the analysis of variance. Significant difference between

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Table 1. Ingredients and chemical composition of basal diet

Ingredients	Percentage %
Ground yellow corn	57.83
Soya bean meal	32.94
Fish meal	3.50
Corn Gluten	3.48
Di calcium phosphate	0.33
Limestone	1.16
DL-Methionine	0.09
Lysine	0.07
Iodized sodium chloride	0.30
Minerals and vitamins premix	0.30
Calculated composition	
Crude protein (%)	24.0
Metabolic energy (Kcal/kg)	2900.0
Calorie/protein ratio (C/P)	120.83
Calcium (%)	0.80
Phosphorus (%)	0.30

treatment means were calculated according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

The feed ingredients used in the control group and treatment group were same but 5% and 10% level of yeast was supplemented in group-2 and group-3 respectively. The effect of yeast culture on body weight gain, feed intake and feed conversion are shown in (Table 2) . It was observed that, yeast at levels of 5% and 10% to the basal diet improved (P>0.05) body weight gain.

meanwhile feed conversion ratio showed significant improvement due to yeast supplementation. This positive enhancement in feed conversion efficiency was confirmed by Zeweil (1997); Chumpawadee *et al*. (2009). The positive response on body weight gain as a result of adding yeast may be due to mannan oligosaccharides (MOS) from yeast cell walls (Newman and Newman, 2001; O'Quinn *et al*., 2001). Some research studies suggest that MOS may improve growth performance in young pigs (Davis *et* al., 1999; Pettigrew, 2000) reported that supplemented yeast increased weight gain and feed conversion ration of broilers.

Table 2 . Effect of dietary treatments on performance of growing Japanese quails

Item	Age in weeks	Treatments		
		Control group	5% yeast	10% yeast
Body weight gain	0 to 2	$41.63^{a} \pm 0.06$	$44.96^{b} \pm 2.07$	$47.83^{c} \pm 1.93$
	2 to 4	$77.31^{a} \pm 0.03$	$84.37^{b} \pm 1.05$	$95.74^{c} \pm 2.23$
	4 to 6	$86.10^{a} \pm 1.07$	$90.73^{b} \pm 2.29$	$112.38^{c} \pm 0.14$
	0 to 6	$204.94^{a} \pm 1.16$	$219.96^{b} \pm 5.41$	$255.95^{c} \pm 4.30$
Feed intake	0 to 2	$40.51^{a} \pm 1.24$	$43.04^{b} \pm 2.25$	$45.42^{c} \pm 1.26$
	2 to 4	$76.29^{a} \pm 1.10$	$82.81^{b} \pm 0.18$	$92.36^{c} \pm 1.53$
	4 to 6	$85.23^{a} \pm 0.38$	$88.14^{b} \pm 1.17$	$99.81^{c} \pm 0.39$
	0 to 6	$202.03^{a} \pm 2.72$	$213.99^{b} \pm 3.60$	$237.59^{c} \pm 2.93$
Feed conversion ratio	0 to 2	0.973 ± 2.35	0.957 ± 1.08	0.949 ± 1.53
	2 to 4	0.986 ± 1.06	0.981 ± 1.83	0.964 ± 0.68
	4 to 6	0.989 ± 2.86	0.971 ± 0.93	0.887 ± 2.78
	0 to 6	1.985 ± 2.34	0.972 ± 1.28	0.928 ± 0.68

In the present study, the data illustrated in (Table 2). indicated that, bakers dried yeast supplementation significantly reduced feed intake, but the body weight gain was significantly higher,

The positive effect on production performance in quails may be due to the number of anaerobic and cellulyticbacteria were increased when the experimental diet was supplemented with yeast

which enhanced lactate utilization and moderate pH of gut, therefore, yeast improves the nutrients digestibility and growth performance revealed that dietary supplement of yeast (S.*cerevisiae*) improves the body performance in broilers. These above results may explain the significant effects of dietary yeast in improving the metabolic process.

CONCLUSION

Dietary yeast have great potential to beneficially affect the gut microflora and hence improves the digestibility and health in Japanese quails. The present study confirms that, the supplementation of bakers yeast as a probiotic in growing Japanese quails diets significantly improved the body performance. It could be concluded that, dietary yeast to growing quails up to 10% level improved the performance and biochemical profile.

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INFLUENCE OF PRE AND POST EMERGENCE HERBICIDES ON WEED CONTROL, YIELD AND ECONOMICS OF TRANSPLANTED RICE (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) is one of the predominant food crop, a grain of life for more than 70 percent of the Asian population and staple food crop for world's poorest and densely populated regions. India is the world's second largest producer (105.3 M t) covering an area of 44.10 M ha, with the productivity level of 2.38 t ha^{-1} (Department of Agriculture and Cooperation 2014). In Telangana state, rice is grown in 2 M ha with an out turn of 6.6 M t (DES, 2013). Application of preemergence herbicides control weeds only in the early stages of crop growth. In order to control the weeds at later stages, application of postemergence herbicides is necessary, hence there is a need to apply herbicides in sequence in order to control weeds effectively.

A field experiment was conducted during *kharif*, 2015 at College farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, to study the effect of sequential application of herbicides on weeds. The experiment was laid out in a Randomized Block Design with eight (8) treatments replicated thrice. The soil of the experimental field was sandy clay loam in texture and medium in available nitrogen, phosphorous and potassium status. Rice variety MTU-1010 was used for experimentation. Herbicide treatments were pretilachlor S 30.7% EC 0.5 kg ha^{-1} as preemergence (PE) followed by (*fb)* azimsulfuron 50% DF 35g ha^{-1} as postemergence (PoE) at 15-20 days after transplanting (DAT), pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* penoxsulam 24% SC 25 g ha^{-1} + pyrazosulfuron ethyl 10% WP 20 g ha^{-1} PoE, bensulfuron methyl + pretilachlor 6.6% G 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE, bispyribac sodium 10% SC 25 g ha^{-1} as early post emergence (EPoE) *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE, pendimethalin + penoxsulam 25% SE 600 g + 25 g ha^{-1} as PE at 4-7 DAT, pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE, hand weeding at 20 & 40 DAT and unweeded control. All the preemergence herbicides were applied as sand mix application at 3 DAT and postemergence herbicides were sprayed at 15- 20 DAT.

Predominant weed flora in the experimental field consisted of four species of grasses, five species of sedges and three species of broad leaved weeds. Among the grasses, *Cynodon dactylon, Echinocloa colonum, Echinocloa crusgalli* and *Paspalum distichum* were predominant. The sedges observed were *Cyperus difformis, Cyperus iria and Scirpus spp*. Among the broad leaved weeds *Eclipta alba, Ammania baccifera a*nd *Ludwigia parviflora* were the major weeds. Similar weed spectrum in transplanted rice was earlier reported by Bhanu Rekha *et al.* (2002).

Among different weed control treatments tested at 30 DAT (Table 1) bensulfuron methyl + pretilachlor @ 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE at 15-20 DAT recorded significantly lower weed dry matter (1.83 g m^{-2}) and was on par with hand weeding twice at 20 & 40 DAT (3.50 g m^{-2}). Highest weed dry matter was recorded with the herbicide treatment pendimethalin + penoxsulam @ 600 g + 25 g ha^{-1} as PE (17.67 g m^{-2}). Pretilachlor S @ 0.5 kg ha^{-1}as PE *fb* penoxsulam + pyrazosulfuron ethyl @ 25 g ha^{-1} + 20 g ha^{-1} as PoE (4.00 g m^{-2}) and bispyribac sodium @ 25 g ha^{-1} *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE at 15-20 DAT (4.33 g m^{-2}) remained on par with each other and hand weeding twice at 20 & 40 DAT (3.50 g m^{-2}).

Higher weed control efficiency (WCE) was recorded with bensulfuron methyl + pretilachlor @ 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE at 15-20 DAT (97.5%). This might be due to higher efficacy of pre mix herbicide followed by postemergence sulfonyl urea herbicide which

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resulted in lower weed dry matter. The results are in conformity with Uma *et al.* (2014). This was closely followed by hand weeding at 20 & 40 DAT (95.4%) which might be due to complete removal of weeds at 20 DAT. The lowest WCE was recorded with pendimethalin + penoxsulam @ 600 g + 25 g ha^{-1} as PE at 4-7 DAT (76.3%).

Weed control treatments significantly influenced the yield and economics of transplanted rice. Highest grain yield (5925 kg ha^{-1}), straw yield (6553 kg ha^{-1}) and harvest index (47.48%) were recorded with hand weeding twice at 20 and 40 DAT which was at par with bensulfuron methyl + pretilachlor @ 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE with grain yield (5610 kg ha^{-1}), straw yield (6290 kg ha^{-1}) and harvest index (47.14%). These results are in conformity with Uma *et al.* (2014).

Highest net returns (Rs. 45665 ha^{-1}) and B:C (2.25) ratio were reported with bensulfuron methyl + pretilachlor @ 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE (Table 2) (Ramachandra *et al.*, 2014 and Uma *et al.*, 2014). This was followed by bispyribac sodium @ 25 g ha^{-1} as EPoE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE at 15-20 DAT (2.14). Similar results with sequential application of herbicides was reported by Deepthi Kiran *et al.* (2010) and Veeraputhiran and Balasubramanian

Table 1. Effect of different weed control treatments on weed dry weight, weed control efficiency, grain yield, straw yield and harvest index of rice

Treatments	Weed dry weight (30 DAT) (g m^{-2})	Weed control efficiency (30 DAT) (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
T_1 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* azimsulfuron 50% DF 35 g ha^{-1} as PoE at 15-20 DAT	3.40 (10.67)	85.9	4788	5533	46.40
T_2 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1}as PE *fb* penoxsulam 24% SC + pyrazosulfuron ethyl 10% WP 25 g ha^{-1} + 20 g ha^{-1} as PoE at 15-20 DAT	2.18 (4.00)	94.7	5482	6197	46.94
T_3 - Bensulfuron methyl + pretilachlor 6.6% G 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	1.68 (1.83)	97.5	5610	6290	47.14
T_4 - Bispyribac sodium 10% EC 25 g ha^{-1} *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	2.26 (4.33)	94.2	5305	6100	46.51
T_5 - Pendimethalin + penoxsulam 25% SE 600 g + 25 g ha^{-1} as PE at 4-7 DAT	4.32 (17.67)	76.3	4337	5230	43.95
T_6 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	3.04 (8.27)	89.6	5117	5817	46.80
T_7 - Hand weeding (20 & 40 DAT)	2.11 (3.50)	95.4	5925	6553	47.48
T_8 - Unweeded control	8.74 (75.50)	-	2483	3687	40.24
SEm (±)	0.178		108	120	
CD at 5%	0.547		332	368	

Original values are given in parenthesis. Data subjected to square root transformation.

(2013). Hand weeding twice (20 and 40 DAT) recorded a lower net returns (Rs. 40838 ha^{-1}) and B:C ratio (1.89) which could be due to higher costs involved in engaging human labour for weeding, whereas unweeded control recorded significantly lower B:C ratio (1.11) over other treatments. This is due to lower grain yield resulting from heavy weed competition.

Effective weed management through sequential application of pre and postemergence herbicides in time not only increased yield but also reduced cost of cultivation. In view of this bensulfuron methyl + pretilachlor @ 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl @ 20 g ha^{-1} as PoE can be recommended for efficient weed control, higher yields, higher net returns and B:C ratio in transplanted rice.

Table 2. Economics of different weed control treatments in rice

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* azimsulfuron 50% DF 35 g ha^{-1} as PoE at 15-20 DAT	38680	70277	31597	1.82
T_2 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1}as PE *fb* penoxsulam 24% SC + pyrazosulfuron ethyl 10% WP 25 g ha^{-1} + 20 g ha^{-1} as PoE at 15-20 DAT	39630	80395	40765	2.03
T_3 - Bensulfuron methyl + pretilachlor 6.6% G 0.66 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	36581	82246	45665	2.25
T_4 - Bispyribac sodium 10% EC 25 g ha^{-1} *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	36306	77851	41545	2.14
T_5 - Pendimethalin + penoxsulam 25% SE 600 g + 25 g ha^{-1} as PE at 4-7 DAT	36481	63767	27286	1.73
T_6 - Pretilachlor S 30.7% EC 0.5 kg ha^{-1} as PE *fb* pyrazosulfuron ethyl 10% WP 20 g ha^{-1} as PoE at 15-20 DAT	37030	75058	38028	2.03
T_7 - Hand weeding (20 & 40 DAT)	45981	86819	40838	1.89
T_8 - Unweeded control	32981	36854	3873	1.11
SEm (±)		1,779	783	
CD at 5%		5,449	2398	

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EFFECT OF FERTILIZERS, BIOCHAR AND HUMIC ACID ON SEED YIELD AND NUTRIENT CONTENT OF MAIZE (*Zea mays* L.) GROWN ON ALFISOLS OF TELANGANA

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Among cereals, maize (*Zea mays* L.) is an important food and feed crop which ranks third after wheat and rice in the world. It is a multipurpose crop that provides food for humans, feed for animals (especially poultry and livestock) and raw material for the industries. This crop has much higher grain protein content than our staple food rice. Maize is a heavy feeder of nutrients hence it is a very efficient converter of solar energy into dry matter. India is the fifth largest producer of maize in the world contributing 3 per cent of the global production (Arif *et al*., 2012).

Current concerns about global food security combined with the need to develop more sustainable agricultural systems and reduced greenhouse gas emissions necessiate many changes in agricultural management. Central to this tenet is the need for replenished soil organic matter reserves to sustain nutrient cycling; and improved WUE that help to mitigate climate change (Jones *et al*., 2012). The application of biochar to agricultural land is receiving increasing attention as an intervention strategy for the sequestration of carbon and as a means of improving soil quality and nutrient cycling thereby aiming at reduced fertilizer use (Richard *et al*., 2012).

Studies suggest that biochar sequesters approximately 50% of the carbon available within the biomass feedstock being pyrolyzed (Kelsi Bracmort, 2010). Humic substances are major components of organic matter, have both direct and indirect effects on plant growth (Sangeetha *et al.,* 2006). Humic acid (HA) improves the physical chemical and biological properties of the soil and influences plant growth. Because of its molecular structure, it provides numerous benefits to crop production.

This present investigation is planned to integrate biochar with humic acid to evaluate its efficacy as a fertility amendment at varied fertiliser levels to increase the maize yield.

This experiment was conducted during *kharif*, 2013 at the College Farm, College of Agriculture, Rajendranagar, Hyderabad situated at 17°19' N latitude, 78°23' E longitude and at an altitude of 542.6 m above mean sea level falls under the Southern Telangana agro-climatic zone of Andhra Pradesh. The details of the material used and the methods adopted during the course of the present investigation are described under appropriate headings.

Some physical and chemical properties of the soil were analysed. Its texture was determined by Bouyoucos hydrometer method (Piper, 1966). The pH and Electrical conductivity of the soil samples were determined in soil: water (1:2) suspension using a glass electrode pH meter and conductivity meter respectively. Organic carbon percentage in soil sample was determined by wet digestion method (Walkley and Black, 1934). Available nitrogen in soil sample was estimated by alkaline permanganate method (Subbiah and Asija, 1956). Available phosphorus in soil sample was extracted with $NaHCO_3$ (0.5 M) and the phosphorus in the extract was estimated by colorimetric method using ascorbic acid as the reductant; the intensity of blue colour developed was read in spectrophotometer at 680 nm (Watanabe and Olsen, 1965). Available potassium in the soils was extracted by employing Ammonium Acetate (NN) and determined by aspirating the extract to the ELICO Flame photometer. Available sulphur in soil samples was extracted with calcium chloride (0.15%) solution (Williams and Steinbergs, 1961) and sulphur in the extract was estimated by turbidimetric method on UV-Visible spectrophotometer at 410 nm (Chesnin and Yien, 1963).

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The two levels of inorganic NPK were significantly the seeds yields being 55.6 and 49.33 q ha^{-1} respectively. Biochar application across the fertilisers and humic acid levels showed a significant increase to 57.04 q ha^{-1} as against 48.35 q ha^{-1} in the control. Individual application of humic acid also had a significant positive effect on the seed yield of maize.

Integrated application of recommended dose of NPK, biochar at 7.5 t ha^{-1} and humic acid at 30 kg ha^{-1} was significant in increasing seed yield. Though in the absence of biochar, 75% NPK put forth significantly lower yield to that of 100% NPK, integration at the highest level of 7.5 t ha^{-1} the yields from the two levels of fertilisers were on a par with the corresponding yields of 58.52 and 55.56 q ha^{-1} (Table 1). It may be inferred that the use of biochar as a soil amendment may reduce fertilizer use while at the same time maintaining high crop yield, even though an increase in crop yield did not occur with increasing fertilizer application rates in the absence of biochar in this study. Similar synergetic effects have also been reported in previous field study (Yamato *et al*., 2006 and Arif *et al*., 2012).

Seed contained significantly higher mean N of 1.074 per cent when the crop was fed with the recommended dose of NPK as compared to1.002 per cent when fertiliser level was reduced to 75%. The increased N content of plant with the application of recommended NPK is due to higher additions into available N pool of the soil. Similar results were reported by Kalhapure *et al.* (2013). The interaction between fertilisers and biochar significantly increased the N content of seed from 0.98 per cent with 75% NPK alone to 1.14 per cent with recommended NPK when applied in combination with 7.5 t $ha^{-1}$of biochar. Even at the reduced level of fertilisers, the integration with biochar at 5 t ha^{-1} was on par with the N content when recommended NPK alone was applied (Table 2). Lehmann *et al*. (2003) found that the NH_4^+ adsorbed by biochar reduces the rate of nitrification thus preventing leaching losses and makes it available to the crop at stages of its requirement with concomitant increase in N uptake by the crop.

Significantly higher P content of 0.484 per cent was obtained with the application of recommended NPK against 0.427 per cent with 75% NPK. Application of biochar levels and humic acid levels were not significant for P content for maize seed. The interaction between fertilisers and biochar resulted significantly increased P content from 0.422 per cent when 75% NPK along with biochar @ 5 t ha^{-1} to 0.498 per cent with recommended NPK along with biochar @ 7.5 t ha^{-1}. These results were on par with treatment receiving recommended NPK alone (Table 3).

Individual application of fertilisers, biochar and humic acid showed a significant influence on K content of maize seed, while integrated effect was not exerted. Recommended NPK resulted in a significantly higher K content of 0.586 per cent against 0.475 per cent with a reduced level (NPK) of fertilisers. Graded levels of biochar application showed a significant increase in K content from 0.520 to 0.590 per cent when applied at 7.5 t ha^{-1}. This might be due to the release of adsorbed K from biochar resulting in higher absorption. Seed K content showed an increase from 0.520 to 0.538 per cent with the application of humic acid at 30 kg ha^{-1} across the fertilisers and biochar (Table 4).

Sulphur content of maize seed was influenced significantly by fertiliser levels alone across biochar and humic acid. Significantly higher mean S per cent of 0.336 was obtained with the application of recommended NPK as against 0.322 with 75% NPK (Table 5). Increased sulphur content with higher NPK level could be due to the synergistic interaction between P and S that enabled enhanced root activity and more absorption of S from the soil.

Application of recommended dose of NPK, biochar at 7.5 t ha^{-1} and humic acid at 30 kg ha^{-1} were significant and resulted in higher mean seed yield. Integration of biochar at 7.5 t ha^{-1} and humic acid with reduced fertiliser dose could result in comparable yield as that of recommended level. The nutrient contents resulted with 75% NPK could be on par with 100% NPK when applied conjunctively with biochar at 5 t ha^{-1} and humic acid.

Table 1. Seed yield (q ha^{-1}) of maize as influenced by fertiliser, biochar and humic acid levels and their interaction

Treatments	**BC @ 0 t ha^{-1}**			**BC @ 5. 0 t ha^{-1}**			**BC @ 7.5 t ha^{-1}**			**Fertiliser Mean**
Fertiliser levels	HA_1	HA_2	Mean	HA^1	HA_2	Mean	HA_1	HA_2	Mean	
100% NPK	52.10	54.43	53.27	56.04	54.01	55.02	56.32	60.71	58.51	55.60
75% NPK	41.22	45.63	43.43	48.17	49.85	49.01	54.43	56.68	55.55	49.33
Mean	46.66	50.03	48.35	52.10	51.92	52.02	55.37	58.69	57.04	52.47
CV (%)	5.22									
CD at 5%	Fert. =1.89 Biochar =2.32 Humic acid =1.89			Fert. x biochar = 3.28 Fert. x humic acid = N.S Biochar x humic acid = N.S Fert. x biochar x humic x acid = N.S						

Table 2. Nitrogen content (%) of maize seed as influenced by fertiliser, biochar and humic acid levels and their interaction

Treatments	**BC @ 0 t ha^{-1}**			**BC @ 5. 0 t ha^{-1}**			**BC @ 7.5 t ha^{-1}**			**Fertiliser Mean**
Fertiliser levels	HA_1	HA_2	Mean	HA_1	HA_2	Mean	HA_1	HA_2	Mean	
100% NPK	0.953	1.065	1.009	1.109	1.038	1.073	1.047	1.236	1.141	1.074
75% NPK	0.844	1.115	0.979	0.971	1.127	1.049	0.939	1.015	0.977	1.002
Mean	0.899	1.090	0.994	1.040	1.082	1.061	0.993	1.125	1.059	1.038
CV (%)	8.36									
CD at 5%	Fert. =0.060 Biochar = N.S Humic acid = N.S			Fert. x biochar = 0.104 Fert x humic acid = N.S Biochar x humic acid = N.S Fert x biochar x humic x acid = N.S						

Table 3. Phosphorus content (%) of maize seed as influenced by fertiliser, biochar and humic acid levels and their interaction

Treatments	**BC @ 0 t ha^{-1}**			**BC @ 5. 0 t ha^{-1}**			**BC @ 7.5 t ha^{-1}**			**Fertiliser Mean**
Fertiliser levels	HA_1	HA_2	Mean	HA_1	HA_2	Mean	HA_1	HA_2	Mean	
100% NPK	0.464	0.489	0.480	0.468	0.481	0.474	0.496	0.500	0.498	0.484
75% NPK	0.422	0.43	0.430	0.404	0.44	0.422	0.417	0.446	0.431	0.427
Mean	0.443	0.459	0.451	0.436	0.460	0.450	0.456	0.473	0.464	0.455
CV (%)	4.94									
CD at 5%	Fert. = 0.016 Biochar = N.S Humic acid = N.S			Fert. x biochar = 0.027 Fert. x humic acid = N.S Biochar x humic acid = N.S Fert. x biochar x humic x acid = N.S						

Table 4. Potassium content (%) of maize seed as influenced by fertiliser, biochar and humic acid levels and their interaction

Treatments	BC @ 0 t ha^{-1}			BC @ 5. 0 t ha^{-1}			BC @ 7.5 t ha^{-1}			Fertiliser Mean
Fertiliser levels	HA_1	HA_2	Mean	HA^1	HA_2	Mean	HA_1	HA_2	Mean	
100% NPK	0.563	0.574	0.569	0.585	0.566	0.580	0.598	0.618	0.608	0.586
75% NPK	0.469	0.474	0.472	0.352	0.415	0.380	0.557	0.587	0.572	0.475
Mean	0.516	0.524	0.520	0.468	0.490	0.480	0.577	0.602	0.590	0.528
CV (%)	7.04									
CD at 5%	Fert. = 0.026 Biochar = 0.032 Humic acid =0.026			Fert. x biochar = N.S Fert. x humic acid = N.S Biochar x humic acid = N.S Fert. x biochar x humic x acid = N.S						

Table 5. Sulphur content (%) of maize seed as influenced by fertiliser, biochar and humic acid levels and their interaction

Treatments	BC @ 0 t ha^{-1}			BC @ 5. 0 t ha^{-1}			BC @ 7.5 t ha^{-1}			Fertiliser Mean
Fertiliser levels	HA_1	HA_2	Mean	HA_1	HA_2	Mean	HA_1	HA_2	Mean	
100% NPK	0.321	0.310	0.316	0.35	0.333	0.342	0.344	0.353	0.349	0.336
75% NPK	0.337	0.305	0.321	0.308	0.328	0.318	0.327	0.325	0.326	0.322
Mean	0.329	0.307	0.320	0.329	0.330	0.330	0.335	0.339	0.337	0.330
CV (%)	5.64									
CD at 5%	Fert. = 0.013 Biochar = N.S Humic acid = N.S			Fert. x biochar = N.S Fert. x humic acid = N.S Biochar x humic acid = N.S Fert. x biochar x humic x acid = N.S						

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Research Notes
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DRY MATTER PRODUCTION AND NUTRIENT UPTAKE OF RICE (*Oryza sativa* L.) AS INFLUENCED BY SYSTEMS OF CULTIVATION AND IRRIGATION REGIMES IN PUDDLED SOIL

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Manual transplanting is the most common practice of rice cultivation in South and South East Asia. In India, 44 per cent area (19.6 M ha) is under transplanting in irrigated lowlands. It is not only time consuming, but also laborious requiring about 30 man days ha^{-1} besides causing drudgery to women folk. This technique also results in non-uniform and inadequate crop stand (Rajendra Prasad, 2004). In all rice growing countries, there is an acute shortage of human labour during transplanting period due to diversion of labour to non agricultural sectors resulting in delay of transplanting, reduced yield and lesser profit. In the context of acute labour shortage, the traditional method of transplanting becomes rather difficult to ensure timely planting with optimum age of seedling. To overcome these difficulties transplanting can be substituted by direct seeding and machine transplanting which could reduce labour needs by more than 20 per cent and increase the yields.

To safeguard and sustain the food security in India, it is quite important to increase the productivity of rice under limited resources, especially water. Future predictions on water scarcity limiting agricultural production have estimated that by 2025 about 2 million ha of Asia's irrigated rice fields will suffer from water shortage in the dry season especially since flood-irrigated rice uses more than 45 per cent of 90 per cent total freshwater used for agricultural purposes (Bouman and Tuong, 2001). Irrigated lowland rice not only consumes more water but also causes wastage of water resulting in degradation of land. In recent years to tackle this problem, many methods of cultivation have been developed. Among the different methods of water-saving irrigation, the most widely adopted is alternate wetting and drying (AWD) irrigation method (Li and Barker, 2004).

A field experiment was conducted at Agricultural Research Institute, Rajendranagar, Hyderabad during *kharif* 2014 (July to Novemeber) with RNR 15048 rice variety of 120 days duration on sandy loam soils of slightly alkaline in reaction and non-saline. The fertility status of the experimental soil was low in organic carbon and available nitrogen with high available phosphorus and potassium.

The experiment was conducted in a strip plot design with 12 treatments and three replications. The treatments comprise of three systems of cultivation (direct seeding with drum seeder, transplanting with machine and conventional transplanting) as main treatments and four irrigation regimes *viz.,* (irrigation of 5 cm when water level falls below 5 cm from soil surface in field water tube (I_1), irrigation of 5 cm when water level falls below 10 cm from soil surface in field water tube (I_2), irrigation of 5 cm at 3 days after disappearance of ponded water (I_3) and recommended submergence of 2-5 cm water level as per crop stage (I_4) as sub plots treatments. Recommended dose of 120 : 60 : 40 N, P_2O_5 and K_2O kg ha^{-1} through urea, single superphosphate and muriate of potash was applied. Urea was applied in 3 splits as basal and top-dressing at tillering and panicle initiation stage. Muriate of potash was applied in 2 splits as basal and at panicle initiation stage and total single super phosphate applied as basal dose. Recommended package of practices were followed and nutrient contents were analysed following standard methods.

Machine transplanting (MTP), among different cultivation systems recorded significantly higher dry matter production (0.81 kg m^{-2}) over drum seeding (DS) and conventional transplanting (CTP) (0.71 and 0.74 kg m^{-2}, respectively) at 80 DAS. There was no significant difference in dry matter production

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between machine transplanting and conventional transplanting and these two were significantly higher than drum seeding at 110 DAS and harvest. Higher dry matter production of the above treatments may be attributed to better establishment of seedlings and more number of tillers m^{-2}. Significantly lower dry matter was recorded with drum seeding at all the stages except at 50 DAS. The lowest dry matter production in drum seeding may be attributed to non uniform plant stand and less number of tillers m^{-2} and this was in conformity with Anbumani *et al.* (2004).

Significantly higher dry matter production was recorded at 80 DAS with recommended submergence of 2-5 cm water level as per crop stage (I_4) and irrigation of 5 cm at 3 days after disappearance of ponded water (I_3) over irrigation of 5 cm submergence with 10 cm drop of water level in field water tube (0.71 kg m^{-2}) and these two were on par with irrigation of 5cm submergence with 5 cm drop of water level in field water tube (0.76 kg m^{-2}).

At 110 DAS significantly higher (9.1%) dry matter production was recorded with recommended submergence of 2-5 cm water level as per crop stage (1.20 kg m^{-2}) over irrigation of 5 cm when water level falls below 10 cm from soil surface in field water tube (1.12 kg m^{-2}) and was on par with 5 cm submergence with 5 cm drop of water level in field water tube (1.19) and 3 DADPW (1.19 kg m^{-2}). Significantly lower dry matter production was recorded with irrigation of 5 cm when water level in field water tube falls below 10 cm from soil(I_2) at all stages of crop growth compared to other irrigation treatments. In the presence of adequate nutrient availability with high absorption of nutrients which lead to more growth and larger photosynthesizing surface and more number of tillers $hill^{-1}$ proceed to its greater accumulation of dry matter production under the recommended submergence of 2-5 cm of irrigation practice(I_4). Similar results were reported by Kumar *et al.* (2014) and Chowdhury *et al.* (2014).

Dry matter (kg m^{-2}) was not significantly influenced by the interaction effect between systems of cultivation and irrigation regimes.

The N, P and K uptakes were significantly higher at flowering (104,108.2 and 17.27 kg ha^{-1}) and harvesting stage with machine transplanting (30.99, 56 and 56.33 kg ha^{-1}) over drum seeding method (87.7, 91.7 and 15.53 at flowering and 27.03, 45.5 and 50.36 kg ha^{-1} at transplanting) and were on par with conventional transplanting (98.6, 104.1 and16.7 at flowering 29.7, 51.2 and 53.7 kg ha^{-1} at harvesting stage respectively) due to large and functional root system and also higher dry matter production per unit area. These results are in agreement with the findings of Chandrapala (2009), Anbumani *et al.* (2004) and Sandhya Kanthi *et al.* (2014).

Among irrigation regimes, N, P and K uptake was significantly higher at flowering (105, 109.4 and 17.09 kg ha^{-1}) and harvesting (31.68, 55.86 and 57.57 kg ha^{-1} respectively) stage(grain and straw) with recommended submergence of 2-5 cm water level as per crop stage over irrigation of 5 cm, when water level falls below 10 cm from soil surface in field water tube (I_2) and was on par with irrigation of 5 cm, when water level falls below 5 cm from soil surface (I_1) in field water tube (90, 95.2 and 15.09 at flowering 25.96, 45.75 and 50.61 kg ha^{-1} at harvesting stage respectively). Significantly lower N, P and K uptake was recorded with irrigation of 5 cm, when water level falls below 10 cm from soil surface in field water tube due to significantly lower dry matter as compared to other treatments. The uptake N, P and K was not significantly influenced by the interaction. These results are in agreement with the findings of Ramakrishna *et al.* (2007) and Chowdhury *et al.* (2014).

Machine transplanting produced higher dry matter, yield and yield attributes compared to other systems of cultivation and more N, P and K uptake fallowed by conventional transplanting over drum seeding method. Among different irrigation regimes higher dry matter and N, P and K uptake was recorded with recommended submergence of 2-5 cm water level as per crop stage (I_4) at all growth stages over irrigation of 5 cm, when water level falls below 10 cm from soil surface (I_2) in field water tube and was on par with fallowed irrigation of 5 cm, when water level falls below 5 cm from soil surface (I_1) in field water tube. Significantly lower dry matter and uptake of N, P and K was recorded with irrigation of 5 cm, when water level falls below 10 cm from soil surface (I_2) in field water tube.

Table 1. Dry matter accumulation of rice (kg m^{-2}) as influenced by different systems of cultivation and irrigation regimes at different growth stages

Treatment	50 DAS*	80 DAS**	110 DAS #	At harvest
Main plot - systems of cultivation (M)				
M_1- Direct seeding with drum seeder (DS)	0.187	0.71	1.10	1.16
M_2- Transplanting with machine (MTP)	0.151	0.81	1.22	1.30
M_3- Conventional transplanting (CTP)	0.172	0.74	1.20	1.28
SEm ±	0.007	0.01	0.02	0.01
C.D at 5%	NS	0.03	0.07	0.03
Sub plot - Irrigation regimes (I)				
I_1- Irrigation of 5 cm, when water level falls below 5 cm from soil surface in field water tube	0.174	0.76	1.19	1.26
I_2- Irrigation of 5 cm, when water level falls below 10 cm from soil surface in field water tube	0.169	0.71	1.12	1.16
I_3- Irrigation of 5 cm at 3 days after disappearance of ponded water (DADPW)	0.171	0.77	1.19	1.25
I_4- Recommended submergence of 2-5 cm water level as per crop stage	0.166	0.77	1.20	1.32
SEm ±	0.005	0.01	0.01	0.01
C.D at 5%	NS	0.03	0.05	0.04
Interaction between different systems of cultivation and irrigation regimes				
Irrigation regimes at same level of systems of cultivation				
SEm±	0.014	0.02	0.04	0.02
C.D at 5%	NS	NS	NS	NS
Different systems of cultivation at same level of irrigation regimes				
SEm ±	0.015	0.02	0.04	0.03
C.D at 5%	NS	NS	NS	NS

*30 DAT, **60 DAT, # 90 DAT, for MTP and CTP

Table 2. N, P and K uptake (kg ha^{-1}) by rice as influenced by different systems of cultivation and irrigation regimes at different growth stages

Treatment	N uptake		P uptake		K uptake	
	Flowering	At harvest	Flowering	At harvest	Flowering	At harvest
Main plot - systems of cultivation (M)						
M_1- Direct seeding with drum seeder	87.7	91.7	15.53	27.03	45.54	50.36
M_2- Transplanting with machine	104.0	108.2	17.27	30.99	56.00	56.33
M_3- Conventional transplanting	98.6	104.1	16.70	29.70	51.29	53.79
SEm ±	2.7	2.0	0.33	0.47	1.92	0.98
C.D at 5%	10.4	7.8	1.28	1.85	7.52	3.86

Treatment	N uptake		P uptake		K uptake	
	Flowering	At harvest	Flowering	At harvest	Flowering	At harvest
Sub plot - Irrigation regimes (I)						
I_1- Irrigation of 5 cm, when water level falls below 5 cm from soil surface in field water tube	98.3	102.9	17.07	30.01	51.54	53.94
I_2- Irrigation of 5 cm, when water level falls below 10 cm from soil surface in field water tube	90.0	95.2	15.09	25.96	45.74	50.61
I_3- Irrigation of 5 cm at 3 days after disappear-ance of ponded water	93.7	97.9	16.75	29.32	50.63	51.86
I_4- Recommended sub-mergence of 2-5 cm water level as per crop stage	105.0	109.4	17.09	31.68	55.86	57.57
SEm ±	2.6	2.1	0.33	0.82	1.59	1.18
C.D at 5%	9.0	7.2	1.14	2.83	5.49	4.09
Interaction between different systems of cultivation and irrigation regimes						
Irrigation regimes at same level of systems of cultivation						
SEm±	9.1	3.9	5.7	1.48	3.29	3.0
C.D at 5%	NS	NS	NS	NS	NS	NS
Different systems of cultivation at same level of Irrigation regimes						
SEm ±	10.8	4.4	6.2	1.87	3.28	3.6
C.D at 5%	NS	NS	NS	NS	NS	NS

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DRY MATTER PRODUCTION AND NUTRIENT UPTAKE OF *RABI* SORGHUM (*Sorghum bicolor* (L.) Moench) AS INFLUENCED BY DIFFERENT DRIP IRRIGATION LEVELS

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Sorghum is the fifth most important cereal crop and is the dietary staple for more than 500 million people in 30 countries and grown in an area of 40 million ha in 105 countries of which USA, India, México, Nigeria, Sudan and Ethiopia are the major sorghum producers.The sorghum area in India is 6.10 million ha (2012-13), out of which 3.78 million ha in the post rainy (*rabi*) season and in Telangana it is grown in 1.09 lakh ha area with productivity of 1015 kg ha^{-1}, respectively (DoES, 2014). Water is increasingly becoming scarce because of erratic distribution of monsoons and uncontrolled exploitation of ground water. The global challenge for the coming decades is to increase the food,fodder and fiber production, with less utilization of water and as water is a limiting input in near future. The present experiment initiated to maximize dry matter with less water.

The field experiment was conducted during *rabi* 2014-2015 with CSH-16 sorghum hybrid at Water Technology Center, College farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad on a sandy clay loam soil, alkaline in reaction and non-saline, low in available nitrogen, high in available phosphorous and available potassium, medium in organic carbon content with field capacity and Permanent wilting point of 21.7 and 9.60 per cent, respectively having available soil moisture of 76.50 mm in 0- 45 cm depth of the recommended dose of fertilizer 100-60-40 kg NPK ha^{-1}, entire dose of P and K was applied as basal before sowing and N applied as fertigation in 6 splits of equal doses at 10 days interval from 15 days after sowing (DAS). The experiment was conducted in a randomized block design with ten treatments of drip irrigation schedules *viz.,* drip irrigation at 0.6 ETc throughout the life (I_1), 0.8 ETc throughout the life (I_2), 1.0 ETc throughout the life (I_3), 1.2 ETc throughout the life (I_4), 0.6 ETc up to flowering 0.8 ETc later on (I_5), 0.6 ETc up to flowering 1.0 ETc later on (I_6), 0.6 ETc up to flowering 1.2 ETc later on (I_7), 0.8 ETc up to flowering 1.0 ETc later on (I_8), 0.8 ETc up to flowering 1.2 ETc later on (I_9) in addition to surface furrow irrigation at 0.8 IW/CPE ratio (I_{10}) and replicated thrice. The data was analyzed statistically and N, P and K were estimated by following standard procedures. Sorghum was sown on October 2014 adopting a spacing of 0.40 m between rows and 0.15 m between plants to mean population of 1,66,666 plants ha^{-1}. Irrigation was scheduled based on USWB class a pan evaporation rates by estimating ETc by adopting suitable pan coefficient based on daily wind speed and relative humidity and crop coefficient as per crop stage as per FAO (Allen *et al*., 1988).

Dry matter production of *rabi* sorghum increased progressively with advance in age of crop up to harvest. Dry matter production was significantly influenced by different drip irrigation regimes at different days after sowing (DAS) except at 30 DAS (Table 1).Significantly higher dry matter production was recorded with drip irrigation scheduled at estimated 1.2 ETc throughout the life over rest of the treatments at 60, 90 DAS and harvest,though it was statically on par with 0.8 or 0.6 ETc up to flowering and 1.2 ETc later on and deficit irrigation at 0.8 ETc up to flowering and 1.0 ETc later on at 90 DAS and harvest and also with irrigation at 1.0 ETc throughout the life at 90 DAS. Dry matter production at 0.8 ETc throughout life, 0.6 ETc up to flowering and 0.8 or 1.0 ETc later on, surface irrigation at 0.8 IW/CPE ratio treatments were at par at harvest.

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Significantly lower dry matter production was obtained with deficit irrigation scheduled at 0.6 ETc throughout the crop life at 60, 90 DAS and at harvest (28.4, 92.9 and 96.4 g plant^{-1}, respectively) than the rest of the treatments except with drip irrigation at 0.6 ETc up to flowering and 0.8 ETc later on at 60 DAS and harvest and surface irrigation at IW/CPE of 0.8 at 90 DAS, which were on par with the later treatments.

Dry matter production recorded with surface furrow irrigation at 0.8 IW/CPE ratio at 60 DAS (35.4 g plant^{-1}) was significantly inferior than drip irrigation at 1.0 or 1.2 ETc throughout the life and was on par with remaining drip irrigation treatments except drip irrigation at 0.6 ETc throughout the life. There was no significance difference in dry matter production between surface furrow irrigation at 0.8 IW/CPE ratio and deficit drip irrigation at 0.6 or 0.8 ETc throughout the life or 0.6 ETc up to flowering and 0.8 ETc later on, at 90 DAS and later treatments was significantly inferior to rest of the treatments. Surface furrow irrigation at 0.8 IW/CPE ratio recorded significantly lower dry mater production at harvest than drip irrigation at 1.2 ETc throughout the life, 0.6 or 0.8 ETc up to flowering and 1.2 later on and 0.8 ETc up to flowering and 1.0 ETc later on and it was on par with rest of the treatments, though significantly higher than drip irrigation at 0.6 ETc.Dry matter production, which reflects the total plant growth, increased with increase in plant height and LAI which might be due to more and larger photosynthetic apparatus of the crop at high frequency irrigation, consequently influencing an assimilates production which have a direct bearing on dry matter production per plant and per unit area. These results corroborates with findings of Garofalo and Rinaldi, (2013) and Roncucci *et al*.(2014).

The uptake of nitrogen (N), phosphorus (P) and potassium (K) was low at 60 DAS and increased gradually up to harvest. N uptake observed at 60, 90 DAS and harvest with drip irrigation at estimated ETc of 1.2 significantly higher (86.4, 134.3 and 177.9 kg ha^{-1}, respectively) than the rest of the drip irrigation treatments and surface furrow irrigation at 0.8 IW/CPE ratio except with drip irrigation at estimated 0.6 or 0.8 ETc up to flowering 1.2 ETc later on at 60, 90 DAS and with drip irrigation with estimated ETc of 0.8 up to flowering and 1.2 later on at harvest (Table 2). Significantly lower N, P and K uptake were recorded at 60, 90 DAS and harvest with drip irrigation at 0.6 ETc throughout the life compared to the rest of the treatments except P up take with drip irrigation at estimated 0.6 ETc up to flowering and 0.8 ETc later on at 60, 90 DAS and harvest and surface irrigation at IW/CPE ratio of 0.8 at 60 and 90 DAS. Surface furrow irrigation at 0.8 IW/CPE ratio recorded significantly higher N uptake compared to drip irrigation at 0.6 ETc throughout the life and was on par with drip irrigation at 0.8 ETc throughout the life, drip irrigation at 0.6 ETc up to flowering and 0.8 ETc later on and drip irrigation at 0.8 ETc up to flowering and 1.0 ETc later on at 60 DAS, though it was significantly lower than other treatments of drip irrigation at 60, 90 DAS and harvest.

Significantly higher P uptake of *rabi* sorghum was recorded at 60, 90 DAS and harvest with drip irrigation at estimated 1.2 ETc throughout the life compared to rest of the treatments except at 90 DAS which was on par with drip irrigation at 0.8 ETc up to flowering and 1.2 ETc later on (Table 2). Surface furrow irrigation at 0.8 IW/CPE ratio recorded significantly lower phosphorus uptake at 60 DAS compared to drip irrigation at 1.2 ETc throughout the life and was higher than drip irrigation at 0.6 ETc throughout the life, though on par with rest of the treatments. Significantly lower phosphorus uptake observed at 90 DAS and harvest, in surface furrow irrigation at 0.8 IW/CPE ratio compared to drip irrigation scheduling treatments except drip irrigation at 0.8 ETc throughout the life and 0.6 ETc up to flowering and 0.8 or 1.0 ET clater on at 90 DAS, though it was significantly higher than drip irrigation at 0.6 ETc throughout the life treatment.

Drip irrigation at estimated ETc of 1.2 throughout the life at 60, 90 DAS and at harvest recorded significantly higher K uptake compared to rest of the treatments except with drip irrigation at 0.8 ETc up to flowering and 1.2 ETc later on and 1.0 ETc throughout the life except drip irrigation at 0.6 ETc up to flowering and 0.8 ETc later on at 60 DAS (Table 2). Surface furrow irrigation at 0.8 IW/CPE ratio recorded significantly lower uptake of potassium at 60 DAS compared to the drip irrigation at 1.0 or 1.2 ETc throughout the life, though it was significantly higher than drip irrigation at 0.6 ETc throughout the life and was on par with rest of the treatments at 60 DAS. Significantly lower potassium uptake recorded at surface furrow irrigation at 0.8 IW/CPE ratio at 90 DAS and harvest compared rest of the drip irrigation

treatments except drip irrigation at 0.6 ETc up to flowering and 0.8 ETc later on and 0.8 ETc throughout the life and it was significantly higher than 0.6 ETc throughout the life.

Nutrient uptake of *rabi* sorghum was higher at optimum soil moisture conditions in the root zone depth which enhance the better crop growth, higher photosynthesis, higher LAI, dry matter and resulted in higher uptake of nutrients. Similar results were reported by Banga *et al.*(1998), Basava *et al.* (2012) and Bharati *et al.* (2007) in maize crop. Lower phosphorus uptake in surface furrow irrigation compared to drip irrigation, may be due to moisture variation from field capacity to permanent wilting point in former one, field capacity level moisture maintained at crop root zone depth in later one.

Dry matter production with drip irrigation at estimated ETc of 1.2 was on par with drip irrigation at estimated ETc of 0.6 or 0.8 up to flowering and 1.2 ETc later on and 0.8 ETc up to flowering and 1.0 later on and superior over other treatments. Uptake of N, P and K recorded with drip irrigation at 1.2 ETc was on par with deficit irrigation of 0.8 ETc up to flowering and 1.2 ETc later on and significantly superior than rest of the treatments. Surface furrow irrigation at 0.8 IW/CPE ratio recorded significantly lower dry matter production and lower uptake of nutrients compared to the drip irrigation treatments at estimated ETc of 1.0 or 1.2 throughout the life and 0.8 ETc up to flowering and 1.2 ETc later on. Significantly lower dry matter and N, P and K uptake were recorded with drip irrigation at 0.6 ETc throughout the life.

Table 1. Dry matter plant^{-1} (g) at different days after sowing of *rabi* sorghum as influenced by different drip irrigation treatments

Treatment	30 DAS	60 DAS	90 DAS	Harvest
I_1 - Drip Irrigation at estimated 0.6 ETc throughout the life	9.1	28.4	92.9	96.4
I_2 - Drip Irrigation at estimated 0.8 ETc throughout the life	10.4	36.6	106.7	119.3
I_3 - Drip Irrigation at estimated 1.0 ETc throughout the life	10.7	43.4	121.9	128.1
I_4 - Drip Irrigation at estimated 1.2 ETc throughout the life	10.9	51.8	131.5	145.6
I_5 - Drip Irrigation at estimated 0.6 ETc up to flowering and 0.8 ETc later on	9.5	32.9	98.7	107.8
I_6 - Drip Irrigation at estimated 0.6 ETc up to flowering and 1.0 ETc later on	9.6	33.4	115.0	121.8
I_7 - Drip Irrigation at estimated 0.6 ETc up to flowering and 1.2 ETc later on	9.2	35.5	125.2	136.0
I_8 - Drip Irrigation at estimated 0.8 ETc up to flowering and 1.0 ETc later on	9.3	37.3	124.2	135.2
I_9- Drip Irrigation at estimated 0.8 ETc up to flowering and 1.2 ETc later on		39.6	128.8	138.4
I_{10}- Surface furrow irrigation at 0.8 IW/CPE ratio with irrigation water of 50 mm	9.2	35.4	101.6	115.2
Mean	9.9	37.4	114.7	124.4
SEm ±	0.5	1.5	3.4	4.8
CD at 5%	NS	4.5	10.0	14.1
CV (%)	8.4	7.0	5.1	6.6

Table 2. N, P and K uptake (kg ha^{-1}) of *rabi* sorghum as influenced by different drip irrigation treatments

Treatments	N uptake			P uptake			K uptake		
	60 DAS	90 DAS	Harvest	60 DAS	90 DAS	Harvest total	60 DAS	90 DAS	Harvest
I_1 - Drip Irrigation at estimated 0.6 ETc throughout the life	41.3	58.8	98.2	7.0	10.9	18.6	33.3	48.3	67.1
I_2 - Drip Irrigation at estimated 0.8 ETc throughout the life	61.5	88.8	128.2	10.5	16.8	26.1	39.3	61.7	81.1
I_3 - Drip Irrigation at estimated 1.0 ETc throughout the life	75.0	118.1	157.4	12.8	21.3	33.7	45.9	73.3	94.1
I_4 - Drip Irrigation at estimated 1.2 ETc throughout the life	86.4	134.3	177.9	16.8	28.8	46.3	50.1	92.0	119.6
I_5 - Drip Irrigation at estimated 0.6 ETc up to flowering and 0.8 Etc later on	52.2	72.7	112.0	8.7	12.9	22.6	34.0	57.2	74.9
I_6 - Drip Irrigation at estimated 0.6 ETc up to flowering and 1.0 Etc later on	74.0	98.1	137.4	11.6	17.9	29.0	40.3	67.6	85.3
I_7 - Drip Irrigation at estimated 0.6 ETc up to flowering and 1.2 ETc later on	79.6	122.8	162.1	12.6	24.7	35.6	42.6	80.0	99.1
I_8 - Drip Irrigation at estimated 0.8 ETc up to flowering and 1.0 ETc later on	67.0	103.6	142.9	11.7	20.8	34.0	41.5	71.9	89.6
I_9- Drip Irrigation at estimated 0.8 ETc up to flowering and 1.2 ETc later on	80.4	126.7	166.1	12.3	25.7	36.0	44.6	83.4	103.2
I_{10}- Surface furrow irrigation at 0.8 IW/CPE ratio with irrigation water of 50 mm	59.1	80.3	119.6	10.8	14.8	23.8	37.8	62.4	77.1
Mean	67.7	100.4	140.2	11.5	19.5	30.6	40.9	69.8	89.1
SEm ±	2.9	3.9	4.2	0.9	1.3	1.4	2.3	2.5	2.6
CD at 5%	8.7	11.6	12.4	2.6	3.8	4.2	6.8	7.5	7.6
CV (%)	7.5	6.7	5.2	13.0	11.5	8.1	9.6	6.2	5.0

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Research Notes
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STUDY ON PROBLEMS PERCEIVED BY THE CARETAKERS ATTENDING TO PATIENTS WITH CANCER

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Becoming a parent, is one of the most powerful of the human experiences, is often accompanied with feelings of celebration and relief, but it can also be a time of anxiety, and stress. The term "Parenting" is derived from the Latin root *pario*, meaning life-giver, and encompasses much more than just the care giving activities parents perform.

As a parent, the fact that the patient has cancer problem is one of the worst situations to face. Everyone will be worried and under considerable problems. These parents are under lot of stress in dealing with their cancer patients. Thus presence of a cancer patient in the family has a multidimensional effect in varied ways such as generating special needs not only for the patient but also for the parents at personal or social or at wider community level. Though parents take the key role in taking care of the patient and the families at the root level, their problems are often overlooked in research. This area of study is almost non- existent in the state of Telangana. Therefore the present study was undertaken to assess the problems perceived by the caretakers attending to cancer patients.

This study was conducted in the twin cities of Hyderabad and Secunderabad with an Expost-facto research design. Purposive sampling technique was adopted to trace the sample based on the availability criteria of the sample. The sample of the study comprised of 80 caretakers of patients with cancer. The data was collected through a direct face-to face interview by using the Self developed open-ended check list, to know the specific problems of caretakers attending to cancer patients. The check list consists of 10 problem areas. The score '0' indicated 'never', '1' indicated 'rarely','2' indicted 'sometimes' and '3' indicated 'always' for each item under each area. The collected data was coded and analyzed by using frequencies and percentages.

Problems perceived by the caretakers

It includes 10 areas such as Parenting, Personal health and care, Career performance, Losing support, Financial, Performing social and recreational activities, Psychological, Embarrassment and Sibling effect.

Table 1. Problems perceived by the care taker attending to patients with cancer (N=80)

S.No	Area	Category	Male		Female		Total (N=80)	
			F (n=24)	%	F (n=56)	%	F	%
1.	Parenting	Mild level	3	12	5	9	8	10
		Moderate level	12	50	31	55	43	54
		Severe level	9	38	20	36	29	36
2.	Personal health and care	Mild level	3	12	6	11	9	11
		Moderate level	11	46	29	52	40	50
		Severe level	10	42	21	37	31	39
3.	Career performance	Mild level	10	42	23	41	33	41
		Moderate level	8	33	19	34	27	34
		Severe level	6	25	14	25	20	25

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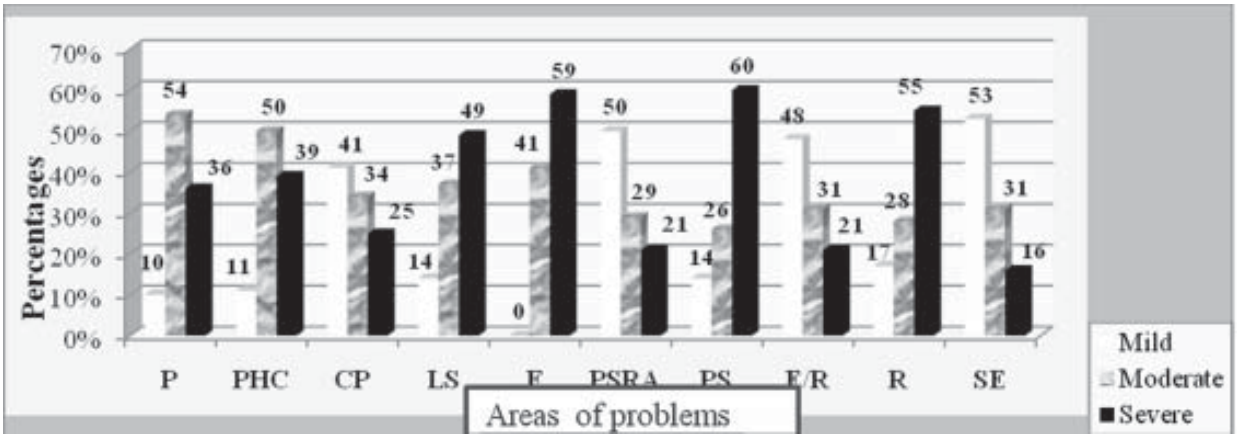
S.No	Area	Category	Male		Female		Total (N=80)	
			F (n=24)	%	F (n=56)	%	F	%
4.	Losing support	Mild level	4	17	7	13	11	14
		Moderate level	8	33	22	39	30	37
		Severe level	12	50	27	48	39	49
5.	Financial	Mild level	--	-	-	-	-	-
		Moderate level	8	33	25	45	33	41
		Severe level	16	67	31	55	47	59
6.	Performing social and recreational activities	Mild level	12	50	28	50	40	50
		Moderate level	7	29	16	29	23	29
		Severe level	5	21	12	21	17	21
7.	Psychological	Mild level	3	12	8	14	11	14
		Moderate level	5	21	16	29	21	26
		Severe level	16	67	32	57	48	60
8.	Embarrassment/ Ridicule	Mild level	11	46	27	48	38	48
		Moderate level	8	33	17	30	25	31
		Severe level	5	21	12	22	17	21
9.	Relationship	Mild level	4	17	10	18	14	17
		Moderate level	6	25	16	29	22	28
		Severe level	14	58	30	53	44	55
10.	Sibling effect	Mild level	16	67	26	46	42	53
		Moderate level	5	21	20	36	25	31
		Severe level	3	12	10	18	13	16



P- Parenting; PHC- Personal health and care; CP- Career performance ; LS- Losing support; F- Financial; PSRA- Performing social and recreational activities; PS- Psychological; E/R- Embarrassment/Ridicule; R- Relationships; SE- Sibling effect

Figure 1. Problems experienced by the care taker attending to patients with cancer

The above (Table1) presents the list of problems perceived by the caretakers attending to patients with cancer. Parenting dealt with attending to the physical needs of the patient such as – bathing, feeding, dressing, brushing, grooming, lifting and carrying the child/patient, medicating and toilet needs. In this area Fifty-four percentage of the caretakers faced problems of moderate level, Ten percentage with mild level and thirty six percentage with faced severe level and problems in attending to the physical needs of the patient.

With regard to caretaker's personal health and care problems such as – asthma, high blood pressure, headache, mental worries, and fifty percentages faced moderate level of health problems, eleven percentage faced mild problems and only thirty nine percentage had severe health problems due to patient ill health.

The third area that is career performance dealt with readjusting job timings, taking up less paying jobs, in ability to take up a job, and seeking transfer. In this area forty-one percentage had mild problems, thirty four percentage moderate level and only twenty five percentage faced severe problems in this area.

The fourth area dealt with losing support from spouse, family, in-laws, relatives, friends, neibours. In this area forty nine percentage of the caretakers faced severe problems due to lack of support, thirty seven percentage moderate and only fourteen percentage of the caretakers very little problem in this area.

The next area dealt with financial problems – visit to doctors and other professional, transportation, medical investigation, aids, appliances /equipments, visit to traditional healers. In these areas, fifty-nine percentage had severe problems and forty one percentage had moderate problems.

Social category dealt with attending to social functions, including recreational activities, pursuing an interesting hobby. In this area only fifty percentage were faced mild level of problems, twenty nine percentage moderate level and twenty one percentage had severe problems.

Further with psychological problems such as mood swings, irritability, resentment, and feeling of powerlessness, low self esteem, and lack of interest in activities, anxiety and depression. In this category six percentage had severe psychological problems, twenty six percentage faced moderate level problems and fourteen percentage faced problems of mild level.

Embarrassment dealt with reaction of family members, relatives, neighbors and community. In this area forty eight percentage of the caretakers felt mild embarrassment with people's reactions.

With regard to facing relationship problems with spouse, family members, in-laws, relatives, friends, neighbors. Fifty five percentage faced severe problems, twenty eight faced problems of moderate level and seventeen percentage problems of mild level.

Sibling effects dealt with caretakers spending less time with other children, studies getting affected, having added responsibilities, being teased by neighbors and community, feeling isolated and worrying about future. In this area, fifty three percentage faced very mild problems.

The results revealed that majority of the caretakers faced problems in finances, as majority of the caretakers belonged to low income group and were illiterates. Most of them were from rural areas; hence they spent more money on transportation in addition to cancer treatment.

This finding was in line with the results of the study of Bayat *et al.* (2008) who concluded that when a patient is diagnosed with cancer, family members are affected both socially and psychologically. Further Northouse (2010) revealed that family caregivers of cancer patients receive little preparation, information, or support to perform their care giving role. However, their psychological needs must be addressed so that they can maintain their own health and provide the best possible care to the patient.

Juanne *et al.* (2003) reported communication issues faced by the parents of patients with cancer i.e medical information, communication at diagnosis, contradictions and confusion, getting the " right" amount of information, good and poor communication, feeling listened to, and errors in medical information. At another level, they felt responsible for their patient condition; they often

lacked knowledge, authority, and power in their dealings with the health care system and its medical care providers.

The study is very much helpful in understanding the unique problems of caretakers attending to cancer patients. The hospital administrative staff should organize Parent education programs with regard to symptoms of Cancer, Medication side effects, Caring the patient, Cancer awareness campaigns, available medical facilities in the hospital etc. The government should provide financial support and respite care to the families. Counseling is very much required at the hospitals for caretakers.

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Research Notes
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EFFECT OF INSTITUTIONALIZATION ON BEHAVIOURAL ADJUSTMENTS OF INSTITUTIONALIZED SCHOOL GOING CHILDREN

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Institutional care is defined as "a group living arrangement for more than ten children, without parents or surrogate parents, in which care is provided by a much smaller number of paid adult carers". In such a type of alternative care the guardianship of the children resides with the institution and there are individuals hired to act as caretakers of the children residing in the institution (Brown 2009). Institutional care is increasing in countries where there is economic transition, because for many families and communities the changes have increased unemployment, migration for work, family breakdown and single parenthood (Carter, 2005; Tinova *et al.,* 2007).Children living in substandard orphanages have been reported to display a variety of other atypical behaviours, including stereotyped self-stimulation, a shift from early passivity to later aggressive behaviour, over-activity and distractibility, inability to form deep or genuine attachments, indiscriminate friendliness, and difficulty establishing appropriate peer relationships (Vorria *et al.*,1998).

A sample of 50 girl children in the age range of 6-12 were selected who are inmates of Children's Home run by government, Department of Women and Child Welfare at yousufguda, Hyderabad. Purposive sampling procedure was adopted in selecting the institution and children were also selected purposively. A list of children within the age range of six to twelve years who are attending primary schools (I to V standard) was prepared with the help of admission register which includes their date of birth and date of admission. Further the names of these children who had spent a minimum of one year in the institution were selected. Finally the sample was selected sequentially from the list to get the required number of respondents.

Interview schedule was used for collecting general information with regard to demographic profile of the sample and Social skills and Problem behaviour checklist (Mathur and Aurora 2005) was used to find out the behavioral adjustment of the sample. The data was tabulated and analyzed by using frequencies, percentages, means, standard deviation, t test and F ratios.

Table 1. Behavioural adjustments of institutionalized children

(N=50)

Sl.No	Behavioural dimensions	Low		Moderate		High		Total	
		F	%	F	%	F	%	n	%
1.	Presentation skills	-	-	12	24	38	76	50	100
2.	Interaction skills	-	-	17	34	33	66	50	100
3.	Conversation skills	-	-	7	14	43	86	50	100
4.	Social integration	-	-	41	82	9	18	50	100
5.	Attitude towards other children	-	-	14	28	36	72	50	100
6.	Attitude towards adults	-	-	11	22	39	78	50	100

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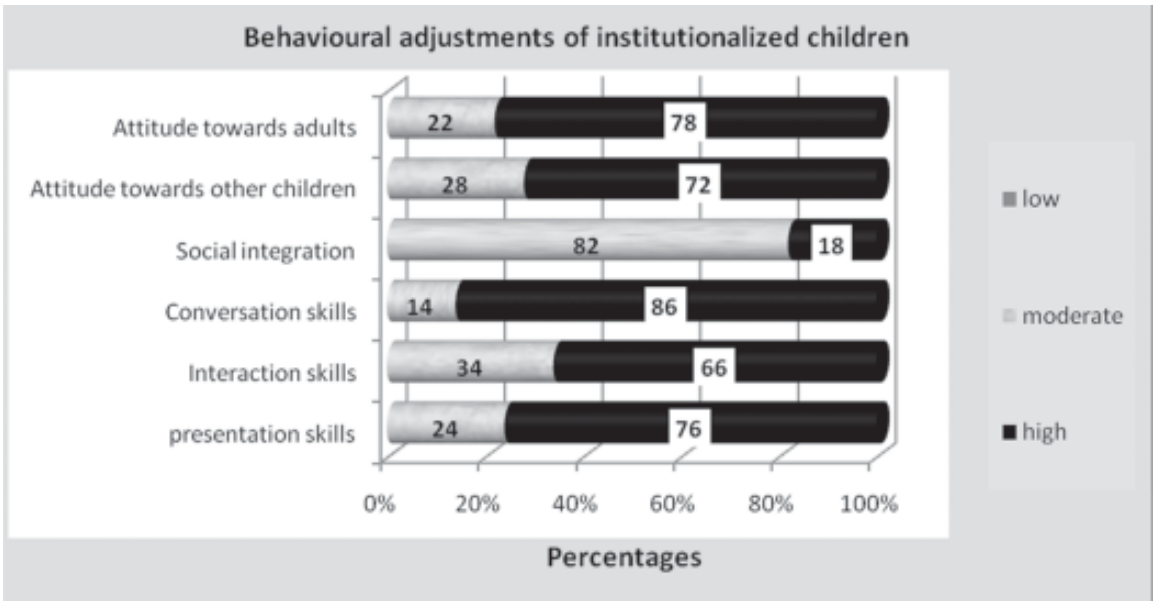

The behavioural adjustments of institutionalized children were presented in the (Table 1.) From the above table, it was evident that presentation skills, interaction skills, conversation skills, attitude towards other children and attitude towards adults of all children were found to be in high category. In the social integration dimension children were found to be in moderate category. Similar results were found by Bough (2008) which revealed that children brought up in institutions may suffer from severe behavior and emotional problems, such as aggressive or antisocial behavior, have less knowledge and understanding of the world, and become adults with psychiatric impairments.

When mean scores of behavioural adjustments according to age were compared no significant differences in behaviour adjustment among three age groups were found, except in interaction skill. (Table 2) mean scores showed that young children had more interaction skills compared to the older children.

Table 2. Differences in Behavioural adjustments of Institutionalized children based on Age

(N=50)

Sl. No						
1.						
2.						
3.						
4.						
5.						
6.						

Table 3. Differences in Behavioural adjustments of Institutionalized children based on duration of institutionalization

(N=50)

Sl.No	Personality dimension	DURATION OF INSTITUTIONALIZTION					
		1-3yrs		3.1-6yrs		t cal	P
		Mean	SD	Mean	SD		
1.	Presentation skills	16.63	2.1	15.9	2.78	0.988	0.16
2.	Interaction skills	11.31	2.3	11.3	2.2	1.677	0.49
3.	Conversation skills	33.42	5.34	34.29	3.045	0.723	0.23
4.	Social integration	27.31	5.03	24.77	4.76	1.78	0.03*
5.	Attitude towards other children	21.68	3.07	20.74	3.78	0.955	0.172
6.	Attitude towards adults	30.15	5.08	28.29	6.08	1.175	0.122

The above table signifies that the duration of institutionalization mad significant difference in social integration. As the duration increased, the social integration decreased in the institutionalized children. Padmaja and Sushma (2014) conducted a study to assess the psychological well being of institutionalized and non institutionalized children and the study found that institutionalized children showed more internalizing and externalizing problems and poor wellbeing.

It can be concluded that majority of the institutionalized orphan children exhibited high problematic behaviour which indicated that they were having low behavioural adjustments. The study also found that independent variables such as age and duration of institutionalization had significant differences with behavioural dimensions. Rutter, *et al*, 2007 also found similar results that duration of institutionalization leads to internalizing and externalizing behaviour problems, social and peer relations, and inattention/hyperactivity. Hence, the study recommends administrators and personnel working for the institutionalized children to provide intervention programme for normative behavioural development of these children.

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SURVEY ON PLANT PROTECTION PRACTICES IN BLACKGRAM (*Vigna mungo* L.)

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India is reportedly the largest pulse growing country in the world both in terms of area as well as production covering 43.30% of land area under pulses with 33.15% production. Blackgram [*Vigna mungo* L. (Hepper)] is the fourth most important pulse crop of India. It belongs to the family leguminaceae; sub family Papilionaceae. Black gram is grown in all the seasons under wide range agro –climatic conditions in different areas of Telangana.

The blackgram crop is prone to the attack by a complex of pests like sucking, defoliators and pod borers at different stages of the crop. Lal and Sachan, (1987) reported that 60 insect species are known to attack blackgram crop at different stages of crop growth in India. The major pests of blackgram are whitefly (*Bemisia tabaci*), leaf hopper (*Empoasca kerri*), defoliator (*Madurasia obscurella*), spotted pod borer (*Maruca vitrata*), pea butterfly (*Lampides boeticus*) and gram pod borer (*Helicoverpa armigera*) Soundararajan and Chitra (2012).

The chemicals (pesticides) are widely used to combat the insect pest problem in pulses. At different periods of crop growth, the crop is treated with different group of insecticides, giving rise to more chance of environmental pollution. A survey in open fields of blackgram is aimed to find out various types of personal protective wear used for the handling of chemicals, prevalent storage practices adopted by the user, to detect dangerous practices and the extent to which safety norms are being followed by the users during the application/treatments, and finally their knowledge concerning the risks of pesticides.

Survey on pesticide use pattern was conducted at farmer's fields in 3 different villages of Nizamabad district (Table 1) to generate information on the existing plant protection practices and elicit farmer's views on plant protection approaches. To evaluate the awareness levels of farmers on pesticides and pesticidal pollution effects in blackgram, the farmers were interviewed personally using a questionnaire.

About 93.33% of the farmers reported the occurrence of insect pests aphids, followed by jassids (86.66%), pod borer (*Maruca vitrata*) (66.66%), whitefly (46.66%), tobacco caterpillar (*Spodoptera litura*) (40%) (Table-2) and major pesticides used by the blackgram farmers are Chlorpyrifos 20% EC (76.66 %), followed by Acephate 75% SP (66.66%), Imidacloprid 17.8% SL (50.00%), Spinosad 48% SC (46.66%), Acetamaprid 20% SP (40%), Monocrotophos 36% SL (36.66%), Chlorantraniliprole 18.5% SC (16.66%) (Table 3).

About 26.66% of the farmers used pesticide mixtures rather than applying single pesticide at a time, this is basically to save time, labour, money and to combat two or more pests with a single spray and 73.33% (Table 4) of the farmers did not use any pesticide mixtures which indicate their knowledge in using pesticides. About 40% of the farmers applied pesticides at 10-15 days (Table 5) interval followed by week (36.66%), 15-20 days interval (16.66%) and 4 days interval (6.66%). It is observed that most of the farmers applied pesticides at 10-15 days interval which shows that farmers are following proper time for the application of pesticides and allowing the pesticides to act upon pests and are also not spraying the pesticides until the pest population build up is noticed again.

About 40% of the farmers were aware of recommended pesticides (Table 4) against different pests, and only 20% of the farmers were aware of pesticide classification based on toxicity. It may be due to illiteracy and literate's negligence that had led

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the farmers for the application of pesticide at improper dosage which indicates that very few farmers look at the colour code triangle on the pesticide container and similar result was reported by Chetna *et al.* (2012) who revealed that there were gender differences regarding reading and understanding of pesticides labels, awareness of the labels and protective covers. Such reports depend on place, crop, purpose of product, use of the product, size of the pack etc. and it gives clear message to all those concerned to educate the farmers about the toxicity codes of pesticides and care to be taken while using the same at both farm and home level.

It was found that 40% (Table 4) of the farmers followed safe methods while storing or mixing or spraying of pesticides and these results are in agreement with the findings of Khan *et al.* (2006) who reported that sixteen per cent of vegetable and fruit growers were found using protective clothing during spraying and Rashid *et al.* (2008) reported that 29% of the growers covered their face and body, 17% covered their body and 17% covered their face at the time of spraying. It is clear that farmers are taking care to avoid the pesticide contamination into their body parts.

In the present study, the most common health problems observed during spraying includes skin irritation (40%), breathlessness (20%), eye irritation (16.66%), cough (13.33%) and head ache (10%) (Table-5) . These findings are in agreement with the findings of Ngowi *et al.* (2007) who reported that 68% of the farmers felt sick after routine application of pesticides and the pesticide-related health symptoms included skin problems and neurological system disturbances (dizziness, headache). Ranga Rao *et al.* (2009) reported that 50% of the Indian farmers had health problems associated with the application of plant protection chemicals.

It is noticed that 73.33% (Table-5) of the farmers preferred to contact the pesticide dealers followed by agricultural officers (13.33%) and scientists (13.33%) for pesticide recommendations which is in line with work done by Khan *et al.* (2006) who reported that 85% usage of pesticides was on the recommendations of pesticide dealers.

Among the farmers, 73.33% of the farmers said that the quantity of pesticides used at their farm is adequate and about 83.33% (Table-4) of the farmers had a perception that pesticides are helpful in getting good returns. About 60% of the farmers said that high pesticide dose gives higher yields and 40% of farmers reported that high pesticide dose will not give higher yield and pesticides are used only to control the pest and majority of the farmers thought that pesticides are helpful in getting good returns. About 60% of the farmers followed crop rotation (Table 5) as an alternative for pesticide use, 26.66% of the farmers followed natural control as an alternative to pesticides and only 13.33% of the farmers followed IPM (Integrated Pest Management) as an alternative for pesticide use and only few felt that integrated pest management practices and natural control measures are alternative to pesticides. This might be due to unavailability of natural pest control/ management components, slow knock down of pests in alternative pest control methods.

Majority of the farmers (66.66%) were not aware about food exports rejections in international trade due to pesticide residues. About 16.66% of the farmers were aware that pesticide residues are found in vegetables and just 6.66% (Table 4) of the farmers knew that pesticide residues in food enter into body and accumulate, 86.66% of the farmers responded that they did not hear about any kind of bad effects due to pesticide residues, 13.33% reported physical impairments, about 33.33% of the farmers were aware that for each pesticide, pre-harvest interval is recommended. Most of the farmers followed common waiting period of 7 days (63.33%) (Table 5) followed by 4 days (26.66%) and 2 days (10%). Majority of the farmers were unaware of pesticide residues, their bad effects, pre harvest intervals and this might be attributed to illiteracy of the farmers and insufficient extension activities.

About 26.66% of the farmers used empty pesticide containers for house or farm purposes. Majority of the farmer's (80%) (Table 5) have simply thrown empty containers in trash and 20% of the farmers buried the empty containers in soil. Proper disposal of empty pesticide containers without using them for house or farm purpose is essential in order to avoid health hazards due to pesticides. Few farmers were using pesticide containers for house or farm purposes as they were unaware of bad effects of pesticides. Disposal of these empty pesticide containers was not carried out in a satisfactory way as majority of the farmers have simply thrown containers in trash.

Table 1. Details of locations for field survey conducted in Nizamabad district.

S.No	Name of the Mandal	Name of the Village	No of Farmers
1.	Bheerkur	Thimmapoor	10
2.	Kamareddy	Sadashivnagar	10
3.	Velpur	Anksapoor	10
			T0TAL:30

Table 2. Information on occurrence of insect pests on blackgram

Particulars		Field(n=30)	
S. No	Insect pest	Frequency	Percentage
1.	Jassids	26	86.66
2.	Whitefly	14	46.66
3.	Aphids	28	93.33
4.	Pod borer (*Maruca vitrata*)	20	66.66
5.	Tobacco caterpillar (*Spodoptera litura*)	12	40

Table 3. Types of insecticides used by blackgram cultivators

Particulars				Field (n=30)	
Sl. No	Chemical name	Trade name	Price (Rs per lit / kg)	Frequency	Percentage
1.	Acephate 75%SP	Starthene	550	20	66.66
2.	Acetamaprid 20% SP	Pride	1600	12	40
3.	Chlorantraniliprole 18.5% SC	Coragen	15000	5	16.66
4.	Chlorpyrifos 20% EC	Dursban	220	23	76.66
5.	Imidacloprid 17.8% SL	Confidor	2400	15	50.00
6.	Monocrotophos 36% SL	Monophos	466	11	36.66
7.	Spinosad 48 % SC	Tracer	13500	14	46.66

Table 4. General awareness of farmers on pesticides and their use

Particulars		Field (n=30)			
Sl.No	Particulars/comments	Frequency		Percentage	
		Yes	No	Yes	No
1.	Are you aware about recommended pesticides against different pests	12	18	40.00	60.00
2.	Are you aware about the pesticide classification based on toxicity	6	24	20.00	80.00
3.	Do you follow safe methods while storing / mixing / spraying pesticides	12	18	40.00	60.00
5.	Do you use pesticide mixtures	8	22	26.66	73.33
6.	Are you aware that pesticide residues are found in vegetables	5	25	16.66	83.33

Particulars		Field (n=30)			
Sl.No	**Particulars/comments**	**Frequency**		**Percentage**	
		Yes	**No**	**Yes**	**No**
7.	Do you know that pesticide residues in food enter into body and accumulate	2	28	6.66	93.33
8.	Are you aware that food exports are rejected due to pesticide residues	10	20	33.33	66.66
9.	Do you think the quantity of pesticides used as adequate	22	8	73.33	26.66
10.	Do you think that pesticides are helpful in getting good returns	25	5	83.33	16.66
11.	Do you think high pesticide dose gives higher yields	18	12	60.00	40.00
12.	Use of empty pesticide containers for house / farm purpose	8	22	26.66	73.33

Table 5. General awareness of farmers on pesticides and their use

Particulars		Field (n=30)	
Sl.No	**Particulars/comments**	**Frequency**	**Percentage**
1.	**Most common health problem observed during spray**		
	Skin irritation	12	40
	Cough	4	13.33
	Breathlessness	6	20
	Eye irritation	5	16.66
	Head ache	3	10.00
2.	**Whom do you contact, for pesticide recommendations**		
	Agricultural officer	4	13.33
	Dealer	22	73.33
	Scientist /Agricultural magazine	4	13.33
3.	**How frequently you apply the pesticides**		
	2 Days	0	0
	4 days	2	6.66
	Week	11	36.66
	10-15 days	12	40
	15-20 days	5	16.66
4.	**Common waiting period you follow after pesticide spray**		
	1 Day	0	0
	2 Day	3	10
	4 Day	8	26.66
	Week	19	63.33
5.	**What type of bad effects you heard due to pesticide residues in food**		
	Cancer	0	0
	Physical impairments	4	13.33
	Not heard about any bad effects	26	86.66
6.	**Best alternative for pesticide use**		
	Crop rotation	18	60
	Natural control	8	26.66
	Integrated pest management	4	13.33
7.	**What is the disposal method you follow for empty pesticide containers**		
	Bury in soil	6	20
	Sell	0	0
	Throw into trash	24	80

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Research Notes
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GLYCEMIC INDEX OF INDIAN FLAT BREADS (CHAPATI)

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The study was undertaken to measure glycemic index of breakfast, chapati made of whole wheat flour (W1) and commercial multigrain flour (C1) and multigrain flour (D1) obtained from the production unit of Department of Foods and Nutrition, College of Home Science, Saifabad, Hyderabad, Blood glucose levels were measured by using “One Touch Select Simple” Glucometer using finger prick method under fasting condition and at 30, 60, 90 and 120 minutes after consumption of the reference food (50 g glucose) and the test food (chapati made of W1, C1 and D1 each providing 50 g CHO). The glycemic index of chapati made of W1 was 54.9, C1 was 53.72 and D1 was 49.7. W 1, C1 and D1 chapati elicited lower glycemic response. Low glycemic index foods are defined as having a glycemic index of 55 or less. The incremental area under the blood glucose response curves (IAUC) to test and reference foods were calculated geometrically using the trapezoid rule. The peak rise and glycemic response of C1 was higher than that of D1 and lower than W1. These differences could be due to the varied gluten content of wheat having shown to influence the glycemic index of chapati.

A number of studies over the past 20 years have shown the beneficial effects of low glycemic index (GI) foods in relation to development of chronic diseases such as type 2 diabetes. The United Nations FAO/ WHO (1998) report recommends that the GI of foods be used in combination with information about food composition to guide food choices for better management and prevention of chronic diseases such as type 2 diabetes and cardio-vascular disease. Already India has the highest number of people with type 2 diabetes in the world (Unwin *et al*., 2009). Controlling postprandial blood sugar is important for the prevention and control of type 2 diabetes and its related complications. There is a large body of evidence to suggest that if a reduction in postprandial glycemia is to be a part of the strategy for prevention and management of diabetes and cardio-vascular disease, the GI is as relevant as the quantity of carbohydrate (Jenkins *et al*., 2008).

Carbohydrate foods (cereal-based), particularly rice and wheat (60–65 %), provide the bulk of the energies in the Indian diet. Almost half (46·9 %) of the daily energies among South Indian population is derived from refined grains.

It is only quite recently that whole grain-based foods of traditional Indian diets have been reintroduced in the Indian market, but the glycemic index of most products has not been tested. The use of cereal – legume blends is deep rooted in all the societies. It provides a better nutrient profile (Neelam Khetarpaul 2009) including an amino acid pattern. There is hence a need to determine the GI of local food products.

Ten healthy young adults in the age group of 22-24 years who volunteered for the study were selected. Before being admitted to the study the subjects were given full details of the study and had opportunity to ask questions or any doubts on the study. An exclusion criteria was moduled or prepared and the subjects were appropriately assessed. Subjects with special diets, with family history of diabetes, intolerant to food / food allergies, chronic illness with any medication and gastrointestinal disorders.

Glucose (50 grams) dissolved in 250 ml of water were served as the reference food and given to all selected healthy subjects to assess the glycemic response. This was used as tool to compare the individual differences in the glycemic response to test products.

Chapati made of whole wheat flour (W1), commercial multigrain flour (C1) and (D1)

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multi grain flour produced in the production unit of Department of Foods and Nutrition, College of Home Science, Saifabad, Hyderabad was used as test food. It contained 72 g, 78 g and 69 g of W1, D1 and C1. It was standardized inorder to provide 50g carbohydrate for the first six days. The subjects were given the standard reference food (glucose). Again for the next six days, the test food containing 50 g carbohydrate was given to each subject and 250 ml of water was provided.

Table1. Description of test foods

Test foods	W1	D1	C1
Raw sample weight providing 50g available carbohydrate (g)	72	78	69
Cooking method and equipment used	Dry heat method using non- stick pan		
Amount of water (ml)	35	42	40
Per chapati average cooked weight (g)	30.0 (15 cm in diameter)	30.1 (15 cm in diameter)	30.1 (15 cm in diameter)

Available carbohydrates on dry weight basis

Blood glucose levels were measured by using “one touch ultra soft” Glucometer by finger prick in the fasting condition and at 30, 60, 90 and 120 minutes after the consumption of the chapati made of W1, D1 and C1. The readings were plotted in the graph.

From the table 5, it can be inferred that W1 and D1 are better than glucose and C1 with respect to glucose level. Further glucose and C1 are not significantly different from each other with respect to glucose level at 60 minutes. There is significant difference between all the foods at 5% level.

Table 2. Average blood glucose levels at different time intervals for reference food (glucose) and test food (chapati made of W1, D1 and C1)

Pro	
Glucos	
W1	
D1	
C1	

Each value is mean ±SD of ten determinants (n=10)

From table 3, it can be inferred that there is no significant difference between all the four foods with respect to glucose levels at fasting.

From table 4, it can be inferred that there is no significant difference between all the four foods with respect to glucose levels at 30 minutes.

From the table 6, it can be inferred that W1 and C1 are better than glucose and D1 with respect to glucose level. Further glucose and D1 are not significantly different from each other with respect to glucose level at 90 minutes. There is significant difference between all the foods at 1% level.

Table 3. Food means (column averages)

W1	D1	Glucose	C1	F value
97.3	95.7	93.7	93.5	0.28NS

NS: Not Significant

Table 4. Food means (column averages)

Glucose	W1	C1	D1	F value
153.2	134	128.2	122.2	2.81

NS: Not Significant

Table 5. Food means (column averages)

Glucose	C1	D1	W1	CD
151.9	136.8	124	119.2	21.56*

* Indicates significance at 5% level.

Table 6. Food means (column averages)

Glucose	D1	C1	W1	CD
140.7	120.6	114.4	111.6	15.97**

** Indicates significance at 1% level

From table 7, it can be inferred that there is no significant difference between all the four foods with respect to glucose levels at 120 minutes.

The incremental area under the blood glucose response curves (IAUC) to test and reference foods were calculated geometrically using the trapezoid rule, ignoring the area beneath the baseline. For each subject, a glycemic index value for each test food was calculated by expressing each subject's incremental area under the blood glucose response curves after the test food as a percentage of the same subject's mean reference incremental area under the blood glucose response curves. Glycemic index of the chapatis were calculated by applying the following formula.

Table 7. Food means (column averages)

Glucose	D1	W1	C1	F value
116.8	108.9	104.4	102.2	0.28 NS

NS: Not Significant

$$\text{Glycemic index} = \frac{\text{IAUC of test food}}{\text{IAUC of reference food}} \times 100$$

Table 8. Glycemic index values (WHO)

Low	<55
Medium	55-70
High	>70

The results of the study were subjected to suitable statistical analysis with the following statistical tests. Mean, standard deviation and analysis of variance was used for blood glucose levels of the selected subjects. (Table 9) shows the mean IAUC and GI of the test foods. The IAUC of reference food was 770 and the IAUC of the test food W1 was 423.03, C1 was 413.64 and D1 was 382.69. The glycemic index values were calculated using the formula. G I= IAUC of the test food/ IAUC of the reference food x 100.

(2001) who reported that whole wheat roti showed low glycemic response as it contains the whole grain components (wheat bran and germ) that are well known for lower glycemic response.

Thus the results demonstrates that the chapati made of whole wheat flour (W1), commercial multigrain flour (C1) and multigrain flour produced in the Department of Foods and Nutrition, College of Home Science, Saifabad, Hyderabad (D1), showed lower glycemic index. Low glycemic index foods are defined as having a glycemic index of 55 or less.

Table 9. Incremental area under the curve (IAUC) and glycaemic index (GI) of the test foods

(n=10) (Mean values)

Test food	IAUC	GI
	Mean	Mean
W1	423.03	54.9
C1	413.64	53.72
D1	382.69	49.7

The present study results demonstrate that W1 and C1and D1 showed lower GI. However, the C1 and D1 chapatis had (49.7) lower GI as compared to C1 chapati (53.72) and W1 chapati (54.9). This would be of great relevance in the context of Southeast Asia, which is currently the epicentre of the diabetes epidemic (Unwin *et al*., 2009) and where the diets that usually consist of high carbohydrate-based foods (cereal staples) leading to high glycemic load (GL) (Radhika *et al*., 2009).

Among the three varieties of chapati, consumption of D1 chapati resulted in lower glycemic response, peak rise and area under curve when compared with C1 and W1 chapati. This finding was matched with study Vijayakumar (2009) and revealed that overall glycemic response at each time interval was higher for wheat chapati than from composite flour chapati. The peak rise and glycemic response of C1 was higher than that of D1 and lower than that W1. These differences could be due to varied gluten content of wheat having shown to influence the glycemic index of chapati.

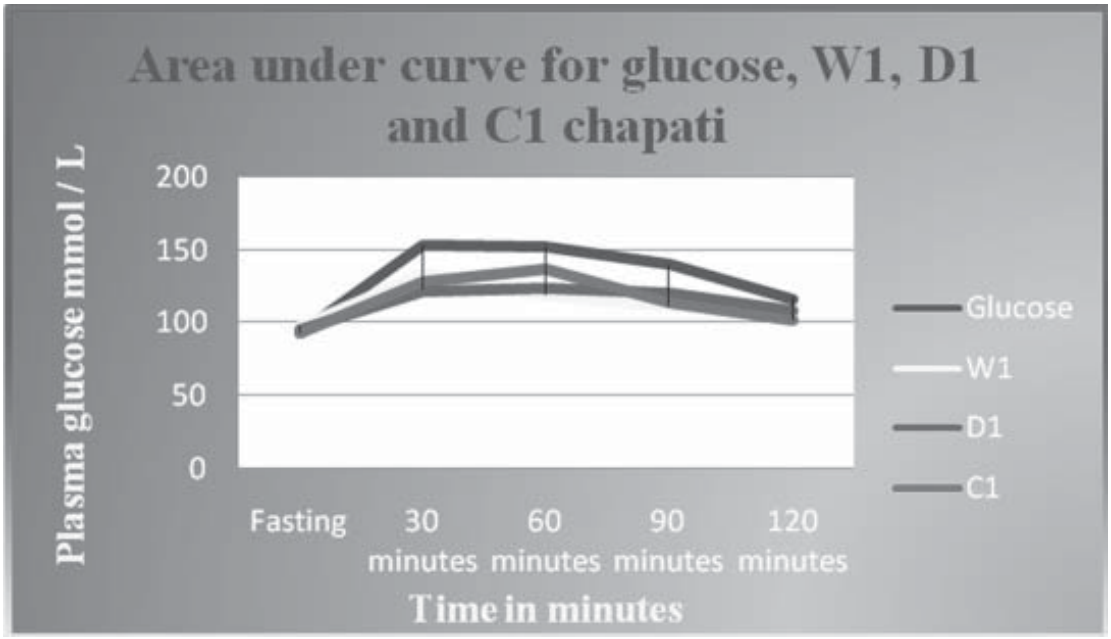
In the present study W 1 chapati elicited lower glycemic response. This finding was matched with a similar observation made by Bjorck *et al.* However, similar results were reported from Radhika *et al.* (2010). It demonstrated that both the whole wheat flour and atta mix rotis showed lower Glycemic Index.

Thus it can be concluded from the present study that chapati made of whole wheat flour (W1), commercial multigrain flour (C1) and multigrain flour produced in the Department of Foods and Nutrition, College of Home Science, Saifabad, Hyderabad (D1) will be more beneficial if diabetics are given these chapatis as they showed a lower peak rise, area under curve and therefore lower glycemic response. However there is a need to conduct this study on large sample size and also with long term supplementation.

Since diabetes is a condition that affects a person throughout the life it is better to modify the diet considering the traditional eating patterns for better and larger compliance. Hence the use of cereal, millets and legume based blends especially of high protein and high fiber sources such as jowar, soy, fenugreek incorporated flours, if encouraged to consume will be helpful in the treatment of diabetics.

In conclusion, present study results demonstrate that W1 and C1and D1 showed lower

GI food values. Hence, these could be incorporated into the Indian diets to replace existing high GI food choices such as refined grains. However, selecting the flour mix could further reduce the overall dietary glycemic load which could be beneficial in a population, which is highly susceptible to type 2 diabetes and insulin resistance.



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DRIP IRRIGATION REGIMES AND FERTIGATION LEVELS INFLUENCE ON YIELD AND YIELD ATTRIBUTES OF *Bt* COTTON

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Cotton, the king of natural fibre is the natures gift to mankind and in India it is mostly grown as rainfed and under furrow irrigation being a row crop. As water is limiting for crop production due to ever increasing competition among different sectors, there is a need for increasing the water use efficiency by producing more crop per drop. Adoption of drip irrigation is one way of increasing the water use efficiency with high irrigation efficiency. Water saving of 30-60 per cent could be possible compared to furrow irrigation since, only active root zone is wetted under drip irrigation. To achieve full potential of micro-irrigation, fertigation is not optional but mandate (Sivanappan, 2004). Fully water soluble fertilizers can be injected via micro irrigation to supply N, P and K in one solution directly to the root zone of the crops. The information on response of *Bt* cotton for drip irrigation as well as fertigation is meager in Telangana. Hence an experiment was planned to study the influence of fertigation levels and drip irrigation regimes on yield and yield attributes of *Bt* cotton.

The experiment was carried out at Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* season, 2013-2014 in randomized block design with nine treatments (Table1), having six fertigation treatments based on surface drip irrigation (1.0, 0.8 and 0.6 Epan) along with fertigation of recommended dose of N and K, compared with conventional method of furrow irrigation and fertilizer application to soil. The soil was sandy clay, moderately alkaline in reaction, non saline, medium in available nitrogen and potassium and high in available phosphorous. The field capacity and permanent wilting point was 19.17% (w/w) and 9.09% (w/w), respectively. The RDF was 150, 60 and 60 kg N, P_2O_5 and K_2O ha^{-1}, respectively and total Phosphorous through single super phosphate was applied as basal to all the treatments before sowing. N and K_2O in the form of urea and sulphate of potash was applied in four splits at 20, 40, 60 and 80 days after sowing (DAS) to soil at 5 cm below and 5 cm away from the plant, in T_7, T_8 and T_9 treatments and for treatments T_1 to T_6, as fertigation in 16 equal splits through urea and sulphate of potash, from 10 to 115 DAS at weekly interval. The irrigation water was moderately alkaline (pH-8.5), Class II (C_4S_1) without any residual alkalinity problem. Cotton (KCH-14k59-Jaadu) was sown on 27th June 2013, by adopting a spacing of 1.2 m between the rows and 0.45 m between the plants within a row to maintain a desired plant population of 18,518 plants ha^{-1}. Irrigations were scheduled based on the USWB Class A pan evaporation replenishment factor of 1.0, 0.8 and 0.6 for drip irrigation treatments through 12 mm lateral with 4 LPH drippers spaced at 50 cm apart and IW/CPE ratio of 0.8 for furrow irrigation with mean irrigation water depth of 50 mm.The calculated irrigation water was delivered in surface irrigation treatment plot directly using a water meter and a flexible pipe.

The data of the experiment presented in (Table 1) indicated that number of monopodial branches $plant^{-1}$ of *Bt* cotton ranged from 2 to 2.7 at harvest and not significantly influenced by different fertigation treatments. Significantly higher number of sympodial branches were observed with 0.8 Epan + 100% RDF (30.3) compared to other treatments except drip fertigation at 1.0 Epan + RDF. Significantly lower number of sympodial branches were observed in rainfed + RDF applied as conventional method (17.3) at final harvest. Furrow irrigation + RDF applied as conventional method (22.7) was on par with 0.6 Epan + 75% RDF (21.3), 0.6 Epan + 100% RDF (23.7) and 1.0 Epan + 75%

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RDF (23.7) and significantly lower than other drip fertigation treatments. Higher plant height resulted in more number of sympodial branches plant^{-1} in drip irrigation and fertigation over furrow and rainfed. Irrigation allowed the plants to set more second, third and greater sympodial branch positions than did the dry land plants (Pettigrew, 2004). Velmurugan *et al.*(2014) also observed higher sympodial branches (36) under drip irrigation with 100 per cent potential evapotranspiration and 100 per cent RDF (150:75:75).

Boll weight (g) of *Bt* cotton crop was significantly higher with drip irrigation at 0.8 Epan + RDF (4.5g) than other treatments except with 0.8 Epan+ 75% RDF (4.4g) and 1.0 Epan + RDF (4.4g). Significantly lower boll weight than rest of the treatments with rainfed + RDF applied as conventional method (3.1g). Boll weight of furrow irrigation + RDF applied as conventional method (3.6g) was on par with drip fertigation at 0.6 Epan + 75 % RDF (3.5g) and significantly lower than other drip fertigation treatments. Drip irrigation at 1.0 Epan + RDF applied as conventional method (4.1 g) was on par with 0.6 Epan + RDF (4.0 g) and 1.0 Epan + 75% RDF (3.9g) and significantly lower than drip fertigation treatments. Fertigation of 200 kg N ha^{-1} to *Bt* cotton significantly increased boll weight by 16.6 per cent over 80 kg ha^{-1} (Singh *et al.,* 2010).The increase in boll weight may be due to production and translocation of higher photosynthates due to favourable soil moisture under drip irrigation. Similar results were reported by Dilip Kumar (2000).

Significantly higher number of bolls was observed in 0.8 Epan + RDF (111.4) over rest of the treatments (Table 1). Significantly lower number of bolls was observed in rainfed + RDF applied a conventional method of soil application (70.1) than all other treatments. Furrow irrigation with RDF applied as conventional method (84.3) was on par with drip fertigation at 0.6 Epan + 75 % RDF (83.5) and significantly lower than other drip fertigation treatments. Higher number sympodial branches plant^{-1} resulted in higher number of bolls plant^{-1} in drip irrigated treatments. Similar results were reported by Singh *et al.* (2010).

Number of seeds boll^{-1} varied considerably in different fertigation treatments. Significantly higher seeds boll^{-1} was recorded with drip fertigation of 0.8 Epan + RDF (40.9) and it was on par with 0.8 Epan + 75% RDF (39.1) and 1.0 Epan + RDF (38.9). Significantly lower number of seeds boll^{-1} were observed in rainfed + RDF applied as conventional method (26.2). Furrow irrigation with RDF applied as conventional method (33.3) was on par with drip irrigation at 0.6 Epan + 75% RDF (34.4) and significantly lower than other drip fertigation treatments though significantly higher than rainfed. Drip irrigation at 1.0 Epan + RDF applied as conventional method (38) was on par with 1.0 Epan + 75% RDF (37.5), 0.6 Epan + RDF (38.1), 0.8 Epan + 75% RDF (39.1) and 1.0 Epan + RDF (38.9) and significantly higher than rest of the treatments except drip fertigation at 0.8 Epan + RDF. Similar findings were reported by Daleswar *et al.*(2006).

Seed index (weight of 100 seeds) of *Bt* cotton ranged from 8.64 to 10.69 g with a mean of 9.90 (g) and significantly higher seed weight was observed in 1.0 Epan + RDF (10.69 g) and it was on par with drip fertigation at 0.8 Epan + RDF (10.57g), 0.8 Epan + 75% RDF (10.3 g), drip irrigation at 1.0 Epan + RDF applied as conventional method (10.26g) and 1.0 Epan + 75 % RDF (10.09g). Significantly lower seed weight was observed in rainfed + RDF applied as conventional method (8.64g) and was on par with drip irrigation fertigation at 0.6 Epan + 75% RDF. Furrow irrigation with RDF applied as conventional method (9.47g) was on par with 0.6 Epan+ RDF (9.85g). Drip irrigation at 1.0 Epan + RDF applied as conventional method (10.26g) was on par with other drip fertigation treatments except 0.6 Epan + 75% RDF and significantly higher than furrow irrigation and rainfed. The findings of this study corroborate with the results reported by Sankarnarayanan *et al*. (2004).

Significantly higher kapas yield was recorded in 0.8 Epan + RDF (4197 kg ha^{-1}) and was on par with 1.0 Epan + RDF (4055 kg ha^{-1}), 0.8 Epan +75 % RDF (4043 kg ha^{-1}) and 1.0 Epan + RDF applied as conventional method (3985 kg ha^{-1}). Significantly lowest yield was observed in rainfed + RDF applied as conventional method (2658 kg ha^{-1}) over rest of the treatments. Furrow irrigation with RDF applied as conventional method (3480 kg ha^{-1}) was on par with 0.6 Epan+ 75 % RDF (3673 kg ha^{-1}) and was significantly lower than rest of the treatments except rainfed. Drip irrigation at 0.8 Epan + RDF recorded higher seed cotton yield over furrow irrigated and rainfed crop due to higher yield components such

as number of sympodial branches plant^{-1} and number of bolls plant^{-1}. There was 20.6 and 16.52 per cent increase in kapas yield due to drip irrigation at 0.8 Epan and fertigation of RDF and 1.0 Epan + RDF over furrow irrigation at 0.8 IW/CPE ratio, respectively. Similar findings were reported by Patil *et al.,* (2008) and Pawar *et al*., (2013).

Based on the results it can be concluded that drip fertigation increased the yield and yield attributes of *Bt* cotton and fertigation of recommended dose of NPK with scheduling of drip irrigation at 0.8 or 1.0 Epan could be the optimal for getting maximum yield.

Table 1. Effect of different N and K fertigation and irrigation levels on *Bt* cotton yield and yield attributes during *kharif*, 2013-14.

Treatment	Monopodial branches plant^{-1}	Sympodial branches plant^{-1}	Number of bolls plant^{-1}	Seeds boll^{-1}	Boll weight (g)	Seed index (g)	Kapas yield (kg ha^{-1})
T1- 1.0Epan+ 100% RDF	2.7	27.0	105.7	38.9	4.4	10.69	4055
T2- 1.0Epan+ 75%RDF	2.3	23.7	90.0	37.5	3.9	10.09	3873
T3- 0.8 Epan+100% RDF	2.7	30.3	111.4	40.9	4.5	10.57	4197
T4- 0.8Epan+ 75%RDF	2.3	25.3	99.7	39.1	4.4	10.30	4043
T5- 0.6Epan+ 100% RDF	2.3	23.7	97.2	38.1	4.0	9.85	3887
T6- 0.6Epan +75%RDF	2.3	21.3	83.5	34.4	3.5	9.23	3673
T7- 1.0 Epan+ 100% RDF – soil application	2.3	26.3	96.5	38	4.1	10.26	3985
T8- Furrow irrigation 100% RDF–soil application	2.3	22.7	84.3	33.3	3.6	9.47	3480
T9- Rainfed + 100% RDF soil application	2	17.3	70.1	26.2	3.1	8.64	2658
Grand mean	2.4	24.2	93.2	36.3	4.0	9.90	3761
SEm ±	0.3	0.8	1.0	0.8	0.1	0.23	83
CD (p=0.05)	NS	2.3	3.1	2.3	0.2	0.70	250
CV (%)	23.1	5.5	1.9	3.6	3.6	4.1	3.8

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Research Notes
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MOLECULAR MAPPING OF BPH RESISTANT GENE(S) IN RICE (*Oryza sativa* L.)

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Rice cultivation covers 9% of world's total arable land of which 89% accounts from Asia (IRRI). India has largest area (43.86 million hectares) under rice with a production of 152.6 million tonnes, next to China (FAO 2013-14). In Telangana rice is cultivated in an area of 16.73 lakh hectares, with a production of 44.8 lakh tonnes. Approximately 52% of the global rice production is lost annually owing to the damage caused by biotic stress factors of which 25% is attributed to the attack by insect pests (Yarasi *et al.,* 2008).

Brown planthopper (BPH), *Nilaparvata lugens* Stal. (Homoptera: Delphacidae) is the most serious pest in most of the rice growing tracts across South, Southeast and East Asian countries. BPH damages rice plants by feeding on the phloem sap causing a characteristic symptom called "hopper burn" (Watanabe and Kitagawa, 2000) and also acts as a vector for viral diseases such as grassy stunt (RGSV) and ragged stunt (RRSV) (Rivera *et al.,* 1966, Ling *et al.,* 1978). Biotypes 1, 2 and 3 are widely distributed in South eastern and Eastern Asia, whereas biotype 4 occurs only in the Indian subcontinent (Khush and Brar, 1991). A change in insect biotypes and disease races poses a continuous threat to increased rice production. Thus there is an urgent need to identify and introduce new genes for BPH resistance from diverse sources into rice. Currently, more than 28 genes (Wu *et al.,* 2014) and 30 QTLs (Fujita *et al.,* 2012) for resistance to BPH have been reported. Four resistant genes (*Bph1*, *bph2*, *Bph3* and *Bph4*) are being used in breeding programs but the varieties with *Bph1* and *bph2* genes have already lost their resistance in many rice growing regions due to change of BPH biotypes (Manisegaran *et al.,* 1993 and Medina *et al.,* 1996). Therefore, it is important to identify new genes from diverse sources and deploy these genes in order to develop durable resistance against this pest.

The experimental material comprised the F_2 mapping population of 126 plants, derived from the cross RNR15048 X BM71. RNR15048 is a fine grain, medium duration but BPH susceptible variety and BM71 is a derivative of MTU4569/ARC6650 // Bunnan///IR64, a medium duration, high yielding culture resistant to BPH. The material was screened

Table 1. Scale used for BPH reaction (IRRI, 2014)

Resistance score	Plant State	Type of reaction
0	No injury	Highly resistant
1	Very slight injury	
3	First and second leaves of most plants partially yellowing	Resistant
5	Pronounced yellowing and stunting or about 10 to 25% of the plants wilting or dead and remaining plants severely stunted or dying	Moderately resistant
7	More than half of the plants wilting or dead	Susceptible
9	All plants dead	Highly susceptible

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against BPH biotype 4 during *Rabi* 2016 at Rice Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad with an objective to map the gene(s) conferring BPH resistance with the help of phenotypic as well as genotypic data. The conventional seed box screening was used to phenotype the F_2 population for BPH resistance. Each plant was scored on 0-9 scale as per Standard Evaluation System for the resistance response to BPH (IRRI, 2014).

Data on scoring of resistance to BPH was recorded on each plant of mapping population. The parents, BM 71 showed moderate resistance (3.3 score) to BPH whereas RNR15048 showed complete susceptibility (9 score). The damage rating of F_2 population ranged from 3.0 to 9.0 with an average of

Table 2. Phenotypic data (damage score) of BPH resistance in RNR15048 X BM71 F_2 mapping population

S.No.	Damage score	S.No.	Damage score	S.No.	Damage score	S.No.	Damage score
1	7	35	7	69	5	103	3
2	9	36	9	70	3	104	7
3	7	37	7	71	9	105	3
4	9	38	3	72	3	106	7
5	3	39	5	73	7	107	5
6	3	40	5	74	9	108	9
7	3	41	9	75	9	109	9
8	3	42	5	76	3	110	3
9	5	43	7	77	3	111	9
10	7	44	3	78	3	112	5
11	5	45	9	79	5	113	7
12	5	46	5	80	9	114	3
13	3	47	5	81	3	115	7
14	9	48	7	82	7	116	5
15	7	49	3	83	9	117	7
16	9	50	9	84	7	118	3
17	9	51	7	85	9	119	9
18	7	52	9	86	7	120	7
19	9	53	7	87	5	121	9
20	7	54	7	88	7	122	3
21	5	55	5	89	9	123	7
22	7	56	5	90	7	124	3
23	9	57	7	91	9	125	9
24	3	58	9	92	3	126	9
25	5	59	7	93	3	RNR15048	9
26	7	60	9	94	9	BM71	3.3
27	7	61	7	95	9		
28	9	62	7	96	7		
29	9	63	5	97	7		
30	3	64	7	98	3		
31	7	65	7	99	7		
32	7	66	9	100	7		
33	7	67	7	101	9		
34	3	68	7	102	3		

6.36 (Table 2). Genetic analysis of BPH resistance was carried out in segregating F_2 population (126 plants) of RNR15048 X BM71. Chi-square test revealed that F_2 population adhered to Mendelian ratio of 1:2:1. The calculated value (0.78) was lower than the tabulated value (5.99) for the phenotypic classes at 2 degrees of freedom at 5% probability level. These results suggested that there was Mendelian segregation for BPH resistance in the population.

Availability of polymorphic markers is necessary for mapping of genomic regions influencing a trait. A set of 398 SSR markers (genomic) and 28 BPH linked markers (total 426 markers) were used in the present study for polymorphism survey between RNR15048 and BM71. Out of 426 markers screened, 71 (16.7%) were found to be polymorphic between RNR15048 and BM71 of which 62 were genomic SSRs and 9 were BPH linked markers.

In the present study, for identifying the SSR marker linked to genomic region influencing BPH, bulked segregant analysis (BSA) was carried out using F_2 bulks after isolation of DNA from 126 individual F_2 plants. Equal amount of F_2 DNAs of twelve resistant plants and susceptible plants were pooled and designated as resistant bulk (RB) and susceptible bulk (SB), respectively. The resistant and susceptible bulks along with parental DNA were screened with the polymorphic SSR markers identified through parental polymorphism survey. Out of 71 polymorphic markers (62 genomic SSRs + 9 BPH linked markers) screened in BSA, only 1 marker *viz.*, RM 23959 on chromosome 9 located at 7.9Mb region showed clear polymorphism in bulks corresponding to their respective parents *i.e.,* marker allele of resistant parent corresponded with allelic pattern in resistant bulk and vice versa which is considered as positive polymorphism. For identification of additional markers in the region of RM23959, 19 markers falling in genomic region between 7.5 to 8.5 Mb on chromosome 9 were used for polymorphism survey, but none of the marker was found to be polymorphic.

The marker RM23959 was used to genotype 126 individual plants of F_2 population. A representative gel picture of genotyping has been shown (Fig.1) and the genotypic data has been presented (Table 3). Single marker analysis of the phenotypic and genotypic data revealed statistically significant association of the marker with BPH resistance at <0.01 level of significance explaining 61% of phenotypic variance.

The present research work is the first step towards identification of the genomic region having major effect for BPH resistance in BM 71 and the marker RM23959 can be used for marker assisted transfer of the gene until further markers are identified in this region. In future, more markers like SNPs can be designed in the reported genomic region to fine map the locus for BPH resistance.

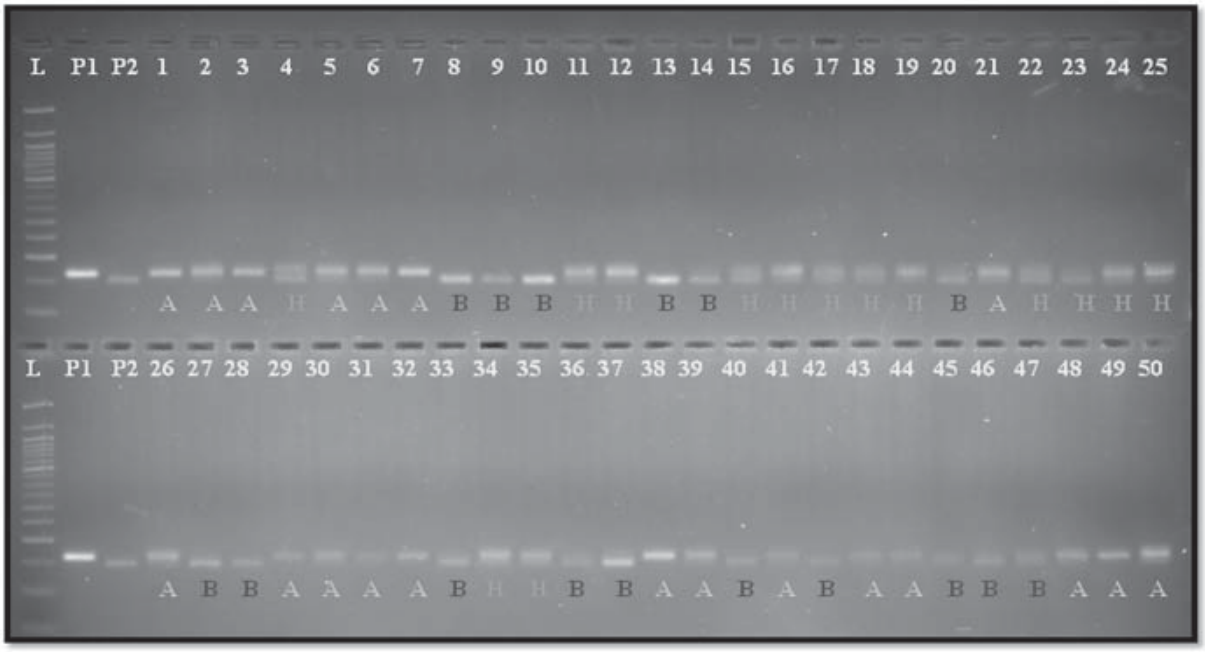

Figure 1. A representative gel picture of genotyping of F_2 population with the marker RM23959 : L- 50bp ladder, P1- RNR15048, P2- BM71 A- RNR15048, H-Heterozygous, B-BM71

Table 3. Genotypic data of RNR15048 X BM71 F_2 mapping population with RM23959

S.No.	Genotype	S.No.	Genotype	S.No.	Genotype	S.No.	Genotype
1	H	33	H	65	H	97	H
2	B	34	A	66	B	98	A
3	H	35	H	67	H	99	H
4	B	36	B	68	H	100	H
5	A	37	H	69	H	101	B
6	A	38	A	70	A	102	A
7	A	39	H	71	B	103	A
8	A	40	H	72	A	104	H
9	H	41	B	73	H	105	A
10	H	42	H	74	B	106	H
11	H	43	H	75	B	107	H
12	H	44	A	76	A	108	B
13	A	45	B	77	A	109	B
14	B	46	H	78	A	110	A
15	H	47	H	79	H	111	B
16	B	48	H	80	B	112	H
17	B	49	A	81	A	113	H
18	H	50	B	82	H	114	A
19	B	51	H	83	B	115	H
20	H	52	B	84	H	116	H
21	H	53	H	85	B	117	H
22	H	54	H	86	H	118	A
23	B	55	H	87	H	119	B
24	A	56	H	88	H	120	H
25	H	57	H	89	B	121	B
26	H	58	B	90	H	122	A
27	H	59	H	91	B	123	H
28	B	60	B	92	A	124	A
29	B	61	H	93	A	125	B
30	A	62	H	94	B	126	B
31	H	63	H	95	B		
32	H	64	H	96	H		

Scoring - RNR15048 – “A”, heterozygotes – “H”, BM71 – “B”

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EFFICACY OF VEGETABLE OILS AND BOTANICALS IN THE CONTROL OF PULSE BEETLE (*Callosobruchus chinensis* L.) IN STORED PIGEONPEA

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Pigeonpea or Redgram (*Cajanus cajan* L.) is an important pulse crop in India and is the main source of protein for vegetarians. The pulse seeds suffer a great damage during storage due to insect attack. Among the insect pests attacking stored products the pulses beetle C*allosobruchus chinensis L*. is a serious one. This insect has been reported from the Philippines, Japan, Indonesia, Sri Lanka, Myanmar and India. It is a notorious pest of chickpea, pigeonpea, mung, motor, peas, cowpea and lentil (Aslam *et al*., 2002). Pulse beetle being an internal feeder connot be controlled with insecticides. It is also not advisable to mix insecticides with food grains. *Callosobruchus* (l) attacking Vigna species was also tested against several oils. Castor oil at 8 ml. kg^{-1} provided complete protection against *Callosobruchus* (Singh *et al*., 1978). Palm and coconut oils at 4 ml kg^{-1} were the most effective protectants of chickpea seeds against *C. chinensis* for 3 months of storage followed by groundnut, rapeseed and mustard oils. Sesame, sunflower and soybean oils were considered inferior to the others (Singh *et al*., 1990). Neem seed oil showed 100% control of *C. chinensis* for 5 months when applied at 10 ml. kg^{-1} chickpea seeds (Das, 1987).

Fumigation with methyl bromide has been the most widely applied management practice for the control of insect pests, including *C. chinensis* in stored grain products (Gao *et al*., 2004 and Mishra *et al*., 2007). However, the ozone depleting effect of methyl bromide has led to restrictions on its use, and the Montreal protocol of the United Nations Environment Programme (UNEP) recommended the phasing out of methyl bromide by 2005 in developed and by 2015 in developing countries (*Anonymous,* 2000). Phosphine resistance is becoming more common (Tyler *et al*., 1983) and is a matter of concern. Further these chemical insecticides enter in the food chain and pollute the environment.

Therefore, there is a need to develop safe alternatives of conventional insecides, fumigants and botanicals to protect stored seed from insect pest infestations. The use of plant products as grain protectants is an age old practice (Weaveret *et al.,* 1992) and appears to be quite safe and promising (Jilani *et al.*, 1998 and Ahmed *et al.,* 2003). Keeping above factors under consideration, the present study on evaluation of vegetable oils and botanicals on against pulse beetle *C. chinensis* was under taken.

The pure culture of *C. chinensis* was raised on pigeonpea seeds and maintained under controlled conditions at 27 $\pm$ 1°C and 70% R.H. The freshly harvested seeds of pigeonpea seeds were sterilized. The sterilized seeds were put in 500g capacity glass jars and 10 pairs of freshly emerged *C. chinensis* adults were released in the jars. The jars were covered with muslin cloth and were kept in BOD incubator for raising the culture. Five vegetable oils *viz*., mustard, groundnut, palm, sesame, sunflower and two botanical *viz*., neem seed kernel and neem leaves were used to coat the seeds at the rate of 5ml kg^{-1} of pigeonpea seed and 50 g kg^{-1} of NSK and 20 g kg^{-1} neem leaves were mixed. Oils were thoughly mixed by vigorougly shaking in different plastic containers filled with seed. Ten pairs of the newly emerged adults of *C.chinensis* were released in each plastic container which was covered with muslin cloth and was tightened with rubber band. The treatments, including control, were maintained in three replications. All the adults were allowed to remain in the container till their natural mortality at room temperature. The per cent damage of seeds was recorded every month up to 6 months. The egg laying was recorded after 15 days of release of beetles in

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each treatment. After complition of 6 months of data recording germination test was conducted. Data subjected to statistical analysis.

The efficacy of vegetable oils and botanicals have caused variable damage of the pigeonpea seeds by *C. chinensis*. Data presented in (Table 1) reveal that no damage was observed in sunflower and castor oil coated pigeonpea seeds and followed by sesame(0.17%), neem(0.17%), mustard(0.17%), groundnut(0.33%) and palm oil (0.33%) coated seeds and all are on par with each other. The highest damage was recorded in untreated control (73.00%) Followed by neem seed kernal(NSK) powder (66.00%) and neem leaves (63.17%) and statistically at par with each other. Similar to present findings Khaire *et al.* (1992) also reported neem and Karanj oils as effective means of protecting pigeonpea seeds in storage from infestation of *C.chinensis*. Similar to present findings Ahmad *et al.* (1988) in an experiment reported that mustard oil was more effective against *C.chinensis* than olive oil. Mummigatiti and Raghunathan, (1977) reported that oils of castor, groundnut and mustard inihibited the multiplication of *C.chinensis*.

Neem seed oil showed 100% control of *C.chinensis* for 5 months when applied at 10 ml. kg^{-1} (Das 1987).

The highest germination was recorded in sunflower (80.00%) mustard (78.33%) and sesame oil (75.00%) coated pigeonpea seeds, followed by palm oil (71.67%) and groundnut oil (66.67%). Comparatively low germination was recorded in castor oil and neem leaves. The weight loss was observed in untreated control (13.33%), NSK powder (11.67%) and neem leaves (11.67%). The present findings corroborate the findings of Tripathi *et al* (2006) who observed that neem oil at 2 ml. kg^{-1} of pigeonpea seeds against *C.chinensis* reduced the weight loss.

Singh *et al* (2006) recorded no weight loss on pea seeds treated with mustard oil at 2 ml. kg^{-1}. Data also revelated that seed germination in various treatments ranged from 68.22 to 91.33 percent. Oils of neem and karanj were the best and equally effective even at 1 percent concentration (89.33 and 84.67% germination, respectively). Khaire *et al.* (1992) reported that neem, karanj and mustard oil when used against *C.chinensis* were safe from seed germination point of view.Singh and yadav (2003) reported no effect on germination of greengram seeds treated with neem, karanj, mustard and olive oil recorded after 6 to 8 hour, 90, 150 and 210 days after treatment. The highest no of eggs/seed was observed in NSK powder (7.05 egg/seed) neem leaves (7.00 eggs/seed) and untreated control. In all the oils zero per cent eggs were observed. Raghuraman and Singh (1997) also reported that neem oil treated seeds received less egg laying by *C.chinensis* than seeds treated with cedar oil. Our results indicate that vegetable oils are not only effective against pulse beetle but also do not effect seed germination.

Table 1. Efficacy of certain botanicals and oils against pulse beetle in stored pigeonpea

Treatments	Dose	Seed damage			Germination(%)			No.of eggs/seed			Percent weight loss		
		1st season	2nd season	Average	1st season	2nd season	Average	1st season	2nd season	Average	1st season	2nd season	Average
Groundnut oil	5 ml.kg^{-1}	0.67 (3.82)	0.00 (0.00)	0.33 (2.70)	63.33 (52.75)	76.67 (61.19)	66.67 (54.81)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Palm Oil	5 ml.kg^{-1}	0.67 (3.82)	0.00 (0.00)	0.33 (2.70)	66.67 (54.76)	76.67 (61.19)	71.67 (57.88)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Sesame Oil	5 ml.kg^{-1}	0.33 (1.91)	0.00 (0.00)	0.17 (1.35)	66.67 (54.76)	83.30 (66.11)	75.00 (60.05)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Neem Oil	5 ml.kg^{-1}	0.33 (1.91)	0.00 (0.00)	0.17 (1.35)	63.33 (52.75)	56.67 (48.02)	60.00 (50.76)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
NSK Powder	50g.kg^{-1}	63.67 (52.98)	68.33 (55.75)	66.00 (54.35)	63.33 (52.83)	70.00 (56.97)	66.67 (54.86)	7.33 (2.88)	7.67 (2.94)	7.05 (2.91)	10.00 (18.42)	13.33 (21.32)	11.67 (19.94)
Neem leaves	20g .kg^{-1}	59.67 (50.74)	66.67 (54.72)	63.17 (52.66)	53.33 (76.90)	43.33 (41.13)	48.33 (44.02)	6.33 (2.70)	7.67 (2.94)	7.00 (2.82)	11.66 (19.87)	11.67 (19.87)	11.67 (19.94)
Mustard oil	5 ml.kg^{-1}	0.33 (1.91)	0.00 (0.00)	0.17 (1.35)	86.67 (68.82)	70.00 (56.97)	78.33 (62.45)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Sunflower oil	5 ml.kg^{-1}	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	86.67 (68.82)	73.33 (58.98)	80.00 (63.52)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Castor oil	5 ml.kg^{-1}	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	33.33 (35.20)	73.33 (58.98)	53.33 (46.89)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (0.0)	0.00 (0.00)	0.00 (0.00)
Control		57.67 (49.45)	88.33 (70.02)	73.00 (58.71)	60.00 (50.83)	63.33 (52.75)	61.67 (51.73)	7.33 (2.88)	8.33 (3.05)	7.83 (2.97)	11.66 (19.87)	15.00 (22.77)	13.33 (21.39)
SEm±		2.40	0.58	1.40	2.49	2.55	2.25	0.03	0.05	0.02	0.66	0.64	0.40
CD at 5%		7.18	1.72	4.17	7.46	7.58	6.68	0.10	0.15	0.05	1.99	1.92	1.19
CV (%)		24.96	5.56	13.87	8.02	7.84	7.12	3.77	5.75	2.03	19.83	17.55	11.39

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