**LR-3680**
**[1-6]**

**Legume Research,**
**Print ISSN:0250-5371 / Online ISSN:0976-0571**

**AGRICULTURAL RESEARCH COMMUNICATION CENTRE**
**www.arccjournals.com/www.legumeresearch.in**

# Agronomic management of CRIDA-18R- a new variety of horse gram (*Macrotyloma uniflorum*) for South India matching monsoon patterns of rainfall

**V. Maruthi*, P. Raghuram Reddy, K.S. Reddy, B.M.K. Reddy and D.G.M. Saroja**

Central Research Institute for Dryland Agriculture (ICAR),
Santoshnagar, Hyderabad-500 059, Telangana, India
Received: Accepted:

**ABSTRACT**

A rainfed experiment was conducted at two contrasting rainfall situations of two different states of South India *viz.*, Hyderabad (Telangana) and Tirupathi (Andhra Pradesh) during 2007-08 to standardize the optimum sowing time, plant densities and fertiliser dose for horsegram variety CRIDA 18R released and recommended for cultivation in South India. Results showed that the second fortnight of August and first fortnight of November were suitable optimum times of sowing in Hyderabad and Tirupathi regions respectively due to receipt of rainfall from South West monsoon and North East monsoon at respective locations. Plant densities of 3.33 lakh per hectare with or without 10N + 20$P_2O_5$ fertilizer dose yielded higher seed in both the regions. However when the sowing was delayed, wisest decision might be to continue the plant densities of 3.33 lakh population per hectare with or without fertilizer. The results revealed that CRIDA-18R responded to fertilizer up to 10 N +20 $P_2O_5$ kg $ha^{-1}$ with 3.33 lakh plant density but for the varied optimum time of sowing at two different centers with occurrence of favourable rainfall situations, revealing a very flexible sowing time for CRHG-18R in South India.

**Key words**: CRIDA 18R, Fertilizer dose, NE monsoon, Optimum sowing time, Plant densities, SW monsoon

## INTRODUCTION

Horse gram (*Macrotyloma uniflorum* (Lam.) verdc) is an arid tropical legume crop known for its medicinal use and nutritional quality. It is consumed as a whole seed, as sprouts, or as whole meal in India, popular at maximum extent in southern Indian states while to some extent in North Indian states. Being a legume, it contributes in fixing atmospheric nitrogen through root nodules and act as organic manure as well. It is suitable as a cover crop in soil and water conservation and an excellent drought tolerant contingent crop in case of delayed monsoon. The whole seed of horse gram is generally utilized as a cattle feed besides being a pulse. The fodder being rich in protein is widely used as a feed to milch animals and horses. It is grown generally by the Indian farmers with zero-fertilizer conditions especially as a contingency crop and hence considered a purely organically grown crop in the real sense by the Indian farmers even today. Pesticides are also not used and the crop is raised strictly under rainfed conditions, with the marginal and small farmers assuring themselves of household nutritional security even under drought conditions. Madhya Pradesh, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka and Rajasthan are the major states growing pulses in India contributing 80% of total pulse production and area (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2010). Pulse production in South India is constrained by low fertility and poor climatic conditions affecting the sufficiency of pulses (Gowda *et al*., 2013).

Most of the farmers are growing local varieties of their own since a long time. These varieties are low yielding, late maturing, non-synchronous in maturity and susceptible to yellow mosaic virus (YMV). Therefore, a variety with high yields, responsive to fertilizers with superior performance under variable monsoon patterns but low rainfall conditions is the need of the hour. Hence, a brown seeded horse gram variety CRIDA-18R was developed from CRIDA and released by Central Varietal Release Committee (CVRC) in 2009 for South India (Reddy *et al*., 2010). It has higher yielding ability of both grain and fodder with high carbohydrate and protein content in the seed along with qualities of non-shattering pods, YMV tolerance, powdery mildew and mites. However the performance of any variety could be improved further with appropriate field management (agronomy) practices of the crop by establishing the package of practices, especially optimization of time of sowing along with plant density and fertilizer requirements to match with the rainfall received in the areas of cultivation. Patil *et al*. (1981) reported good performance of horse gram crop under delayed *kharif* sowing as a contingent crop helpful in planning crops suitable to aberrant weather conditions. Keeping this in view, the field trials were conducted in two contrast rainfall regions to identify the suitable sowing time for the horse gram variety CRIDA-18R and appropriate agronomic management measures in terms of optimum plant density in combination with fertilizer requirements for varied sowing dates.

*Corresponding author's e-mail: vmaruthi@crida.in

## MATERIALS AND METHODS

A field experiment was conducted at two centers of contrasting rainfall situations for two years consecutively. One trial was conducted at Hayathnagar Research Farm, CRIDA, Hyderabad (Telangana state), another was at Regional Agricultural Research Station (RARS) Tirupati centers (Andhra Pradesh state) of the National Network Research Project on Arid Legumes to find out the plant density to be adopted and the modifications in the fertilizer requirement from the recommended doses for the horsegram crop with varied sowing dates. These trials were conducted purely under rainfed conditions.

**Hyderabad Centre**: The experimental soils are red sandy loams (Alfisols) with 70% sand, 23% silt and 7% clay as textural components. The site is located at 17.37° N and 78.48° E. The soils were endowed with organic carbon (0.45-0.5%), available nitrogen (190 kg $ha^{-1}$), phosphorus (10 kg $ha^{-1}$) and potassium (220 kg $ha^{-1}$ ) contents with neutral pH (7.0). Hayathnagar Research Farm of CRIDA receives 760mm rainfall on an average from South West monsoon. The monsoon season ranges from June to September. However, delay in onset or breaks in monsoon are prevalent during crop growth period.

The experiment was conducted in Hyderabad with two dates of sowing especially late *kharif* depending upon the rainfall in the respective centres (Reddy *et al.,* 2010) with two levels of plant densities and three combinations of nitrogen and phosphorus levels besides a no fertilizer check. The experimental design was a split plot with dates of sowing in the main plots and combinations of spacing and fertilizer levels as sub plots in each trial, at each center. The treatments were replicated four times. Two dates of sowing under late *kharif* conditions during August and September with two plant densities of 3.33 and 2.66 lakh population per hectare and fertilizer levels of 0N + 0$P_2O_5$, 0N +10$P_2O_5$, 10N + 20 $P_2O_5$, 20N + 40 $P_2O_5$ comprising recommended dose of fertilizer (20N+40$P_2O_5$), half of the same (10N+20$P_2O_5$), only phosphorus @ 10 kg $P_2O_5$ and no fertiliser control. Nitrogen and phosphorus were applied as per treatment through urea and Single Super Phosphate (SSP).

**Tirupati Centre**: Tirupathi is situated between 13° 40' N and 79° 20' E with mean monthly temperatures hovering between 29.7° to 32.4° C during June to September and 25° to 28.2°C during October to December. The South West monsoon and North East monsoon are the major sources of rainfall for Tirupathi centre. On an average Tirupathi receives 50-55% rainfall through South West monsoon (June to September) and 45-50% rainfall from North East monsoon (October to December). Soils are red sandy loams with 80% sand, 15% silt and 5% clay. Theses soils are low in organic carbon (0.45%) and available nitrogen, medium in phosphorus and potassium contents.

Depending upon the rainfall situations, sowing was staggered to two dates, one in September and another in November (due to receipt of rainfall by the end of October, second date of sowing was carried out on 1st November) with the plant densities of 3.33 and 2.66 lakh population per hactare with four levels of fertilizer combinations 0N +10$P_2O_5$, 10N + 20 $P_2O_5$, 20N + 40 $P_2O_5$ comprising of recommended dose of fertilizer and 0+0 N, $P_2O_5$ no fertilizer control (Annual Report, 2007-08). Nitrogen and phosphorus were applied as per treatment through urea and SSP. The crop was sown with a preparatory tillage and no top dressing was carried out during the crop growth period.

The data were subjected to statistical analysis using the F-test (Gomez and Gomez, 1984). Critical difference (CD) values at P=0.05 were used to determine the significance of differences between mean values of treatments

Farmer Field Trials were conducted during 2007-2008 in five farmers' fields each simultaneously in Nalgonda and Chittoor districts of Telangana and Andhra Pradesh respectively for comparative performance of CRIDA-18R the variety with the local cultivar, which is presented in the Figure 3.

## RESULTS AND DISCUSSION

Based on the study conducted at two centres of contrast rainfall situations (Hyderabad and Tirupathi), it is evident that the rainfall quantity received and its distribution was uncertain and varied due to the variability in both South West and North East monsoon rainfall. The existing climate variability affected the horse gram yields either due to lack of suitable varieties, inefficient water use or no application of fertilisers and low soil fertility. By experimenting on the date of sowing, which is affected with the short window of sowing operation, improvement in the production potentials of horse gram could be envisaged with optimum density and fertilizer application.

Normally the crops suitable to sow with the timely onset of monsoon varied in these two centres from sorghum, maize to groundnut *etc*. With the failure or delay in onset of monsoon, the sowing of horsegram is taken up as a contingent crop, mostly of local cultivars. Past evidence shows that mostly local non-descript varieties of horse gram were sown as a contingent crop for food security of a small holder under rainfed conditions. Although basically it's performance as a contingent crop is poor, low yielding local cultivars further reduced the yields. According to Yasin *et al*., (2014) horse gram grows and thrives in a wide range of geographical locations varying in water availability; therefore for further improving its performance, standard agronomic management practices are necessary. Hence, before introducing the new cultivars, standardization of suitable agronomic management practices for the improved performance of new cultivar is

required to obtain maximum yield potential, in this case it was CRIDA-18R. Accordingly, judicious combination of fertilizer dose and population density matching with the sowing time was evaluated in both two research centres as well as in farmers' fields.

**Rainfall:** In Hyderabad region, 2nd fortnight August and Sep sowings experienced 225 and 69 mm respectively, with first sown crop experiencing no dry spell while the second date (Sep sown crop) experienced dry spell at pod filling stage. Similar to Hyderabad region, out of two dates of sowing in Tirupathi region of both Sep and Oct/Nov, first date sown crop has experienced wet spell at flowering stage (Fig 1). Moderate moisture deficits occurred for the August sown horse gram crop in Hyderabad region while the deficits occurred at pod filling stage for Sep sown crop. In Tirupathi region, the first sown Sep crop experienced wet spell during flowering affected the yields. However, the stark difference in both the regions was in receipt of pre sowing rainfall. First date sown crop in Hyderabad, received 99 mm of pre sowing rainfall while the second dated sown crop of Tirupathi region received 255 mm pre sowing rainfall and for other dates of sowing not much of pre sowing rainfall was received.

**Effect of sowing date on yields:** Limited work was reported till now on suitable horse gram varieties and their management practices matching with the rainfall situations. However, with the crop improvement, it is imperative to advocate the farmers about the cost effective agronomic technologies like planting horse gram in the dates that match with the appropriately suitable rainfall amounts (transient excesses /deficits rainfall), with optimum plant densities and corresponding fertliser requirements.

The date of sowings vary from region to region as the date of onset of monsoon, rainfall amounts and distribution in the respective regions differ. Normal date of sowing for most of the rainfed crops in Hyderabad region is the first fortnight of June as it receives South West monsoon and lasts up to September. However, if the horse gram is sown during June month, the crop does not enter into the stage of reproduction, so only fodder yields are harvested due to its photo and thermo sensitive nature (flowering and seed set does not take place). Further, due to its drought tolerance ability (owing to differential enzyme activity, reduction in total sugar production and structural compaction for conservation of energy as a drought tolerant mechanism was explained by Yasin *et al*, (2014)) and nitrogen fixing capacity, horse gram generally preferred as a contingent crop when the monsoon is delayed or if *kharif* crops fail due to early season drought, hence the sowing of horse gram starts from August onwards. Hence, the trials for standardizing optimum sowing dates consisted of months of August and September. Table 1 shows higher yields realized by the August sown horse gram crop (861 kg $ha^{-1}$) in Hyderabad and nearly 52% reduction in yields observed in the September sown crop (450 kg $ha^{-1}$). This was due to lack of sufficient rainfall especially at pod filling stage as Hyderabad received only a total rainfall of 69 mm in 6 rainy days at pod filling stage. In contrast, the August crop had the advantage of receiving 225 mm rainfall in 18 rainy days with no

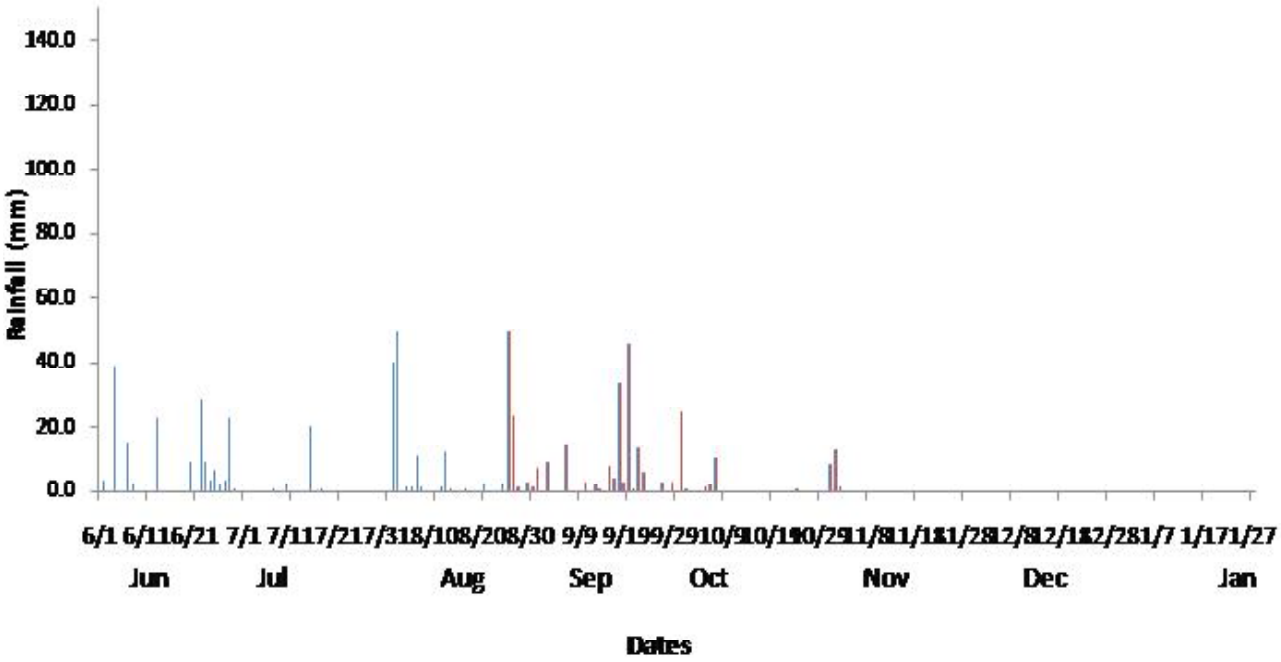


**Fig-1:** Daily rainfall distribution at HRF of CRIDA, Hyderabad during 2007-08 ( Red coloured line shows the horsegram cropped period)

**Table 1:** Effect of sowing time, plant densities and fertilizer dose on seed yield (kg ha$^{-1}$) of CRIDA-18R horsegram variety in CRIDA, Hyderabad during 2007-08

| Sowing time | Plant Densities (lakh plant population) | Fertilizer,N+$P_2O_5$ in kg ha$^{-1}$ | | | | |
|---|---|---|---|---|---|---|
| | | 0+0 | 0+20 | 10+20 | 20+40 | Mean |
| Date 1(August) | 3.33 | 782 | 885 | 926 | 964 | 889 |
| | 2.66 | 754 | 819 | 873 | 890 | 834 |
| | Mean | 768 | 852 | 900 | 927 | 861 |
| Date 2(September) | 3.33 | 597 | 591 | 524 | 573 | 546 |
| | 2.66 | 415 | 300 | 313 | 389 | 354 |
| | Mean | 506 | 395 | 419 | 481 | 450 |
| | Mean | 637 | 624 | 660 | 704 | 656 |
| CD at 5% | Dates | 28.1 | | | | |
| | Plant Densities | 27.4 | | | | |
| | Fertiliser | 39.7 | | | | |
| | Interaction | 25.2 | | | | |

conspicuous deficit rainfall conditions at pod filling stage. Therefore, crop yields reduced with the delay in sowing dates in Hyderabad region (Figure 1). This was in contrast to the situation in Tirupathi region. Normally Tirupathi region receives nearly 45% rainfall through North East monsoon; hence, the sowing dates should able to exploit the rainfall from this monsoon. In this region, sowing date during September yielded 62% (1222 kg ha$^{-1}$) poorer than the October/November sown horse gram crop (1977 kg ha$^{-1}$) due to the disadvantageous conditions of wet spells it had experienced during flowering stage as was shown in Table 2. Receipt of such high rainfall spells caused delay in flowering, which in turn might have caused poor partitioning of dry matter towards pods reducing yields. Delay in flowering must also be balanced against the quantum of growing season left for pods to mature also. If the vegetative growth period was protracted, final yield might have decreased despite the increased dry matter production. Both the regions differed significantly in the dates at which horse gram to be sown as 52% reduction in seed yields was observed when the sowing dates were delayed in case of Hyderabad region while delayed sowing up to Oct/Nov enhanced yield realization by 62% in Tirupathi region.

**Effect of plant densities and fertilizer doses on yields:** Irrespective of the growing location, sowing window or fertilizer doses, plant density of 3,33 lakh per hactare yielded significantly higher (6-9%) than the density of 2,66 lakh per hactare. In both Hyderabad and Tirupathi regions, yield reduction was observed with reduced plant densities (2.66 lakh ha$^{-1}$), however with delayed sowing dates the rate of reduction was more (20-35%) with reduced plant densities. This emphasized the balancing of source-sink relationship when the moisture deficits occur (Patra and Nayak, 2000). However, the loss in yields could be compensated to an extent of 10-25% by increasing plant densities to 3.33 lakh ha$^{-1}$.

Fertilizer doses of 0+20 N, $P_2O_5$ and 10+20 N, $P_2O_5$ performed equally well irrespective of the dates of sowing and plant densities, since the application of phosphorus made the difference. Therefore, as suggested by Keshava *et al*., (2005), the difference in yields due to phosphorus levels could be attributed to improved dry matter production per plant and its distribution in to various plant parts. Further

**Table 2:** Effect of sowing time, plant densities and fertilizer dose on seed yield (kg ha$^{-1}$) of CRIDA-18R at Tirupathi Centre of National Network Research Project on Arid Legumes during 2007-08

| Sowing time | Plant Densities (lakh plant population) | Fertilizer, N+$P_2O_5$ in kg ha$^{-1}$ | | | | |
|---|---|---|---|---|---|---|
| | | 0+0 | 0+20 | 10+20 | 20+40 | Mean |
| Date 1(September) | 3.33 | 1160 | 1266 | 1404 | 1654 | 1371 |
| | 2.66 | 1589 | 1208 | 1118 | 1079 | 1248 |
| | Mean | 1280 | 1187 | 1176 | 1245 | 1222 |
| Date 2(Oct/November) | 3.33 | 1944 | 2074 | 2222 | 2364 | 2151 |
| | 2.66 | 2056 | 1651 | 1799 | 1281 | 1696 |
| | Mean | 2081 | 1886 | 2019 | 1925 | 1977 |
| | Mean | 1681 | 1537 | 1598 | 1585 | 1600 |
| CD at 5% | Dates | 55.8 | | | | |
| | Plant Densities | 68.3 | | | | |
| | Fertiliser | 78.9 | | | | |
| | Interaction | 44.1 | | | | |

**Source: Annual Report, NNRPAL, 2007-08**

increase in phosphorus levels did not increase the seed yields significantly. Further more, September sown crop in Tirupati region experienced wet spell, which might have washed out the nutrients applied in the form of fertilizers. Horse gram crop without fertilizer as a farmers' practice resulted in 782 kg $ha^{-1}$ and the crop responded up to 10N+20$P_2O_5$ positively. Therefore, variations in yields must be due to differences in sowing time, plant densities and fertilizer application, affecting dry matter accumulation, distribution and conversion as well.

**Farmer Field Trials:** Farmer field trials were conducted with 5 farmers each in Nalgonda and Chittoor districts respectively in which CRIDA-18R performance was compared with the local variety for assessing its advantages at farmers' field level (Figure 3). Nalgonda district of Telangana state farmers reaped 1770 kg $ha^{-1}$ in comparison with the 1420 kg of local variety per hactare, which was a 26.6% increase with CRIDA-18R while it out yielded (955 kg $ha^{-1}$) the local variety (745 kg $ha^{-1}$) in Chittoor district of Andhra Pradesh state by 28% further confirming its high

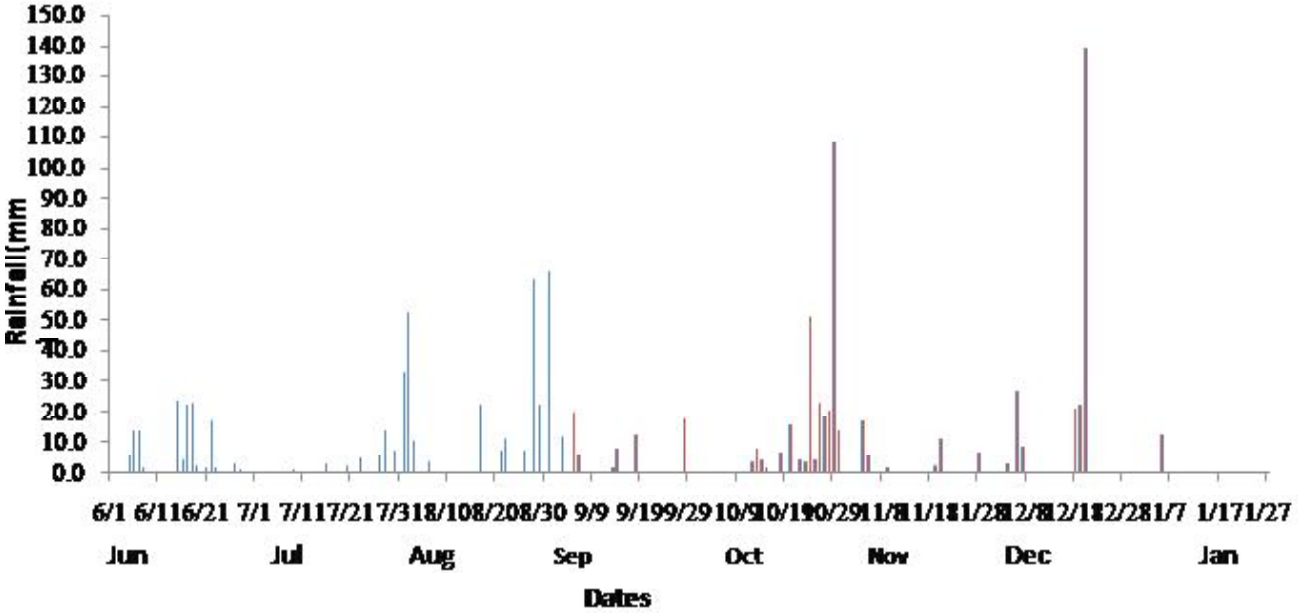


**Fig-2:** Daily rainfall distribution at Tirupathi centre during 2007-08 ( Red coloured line shows the horsegram cropped period) (Source: Annual Report RARS, Tirupathi, ANGRAU)

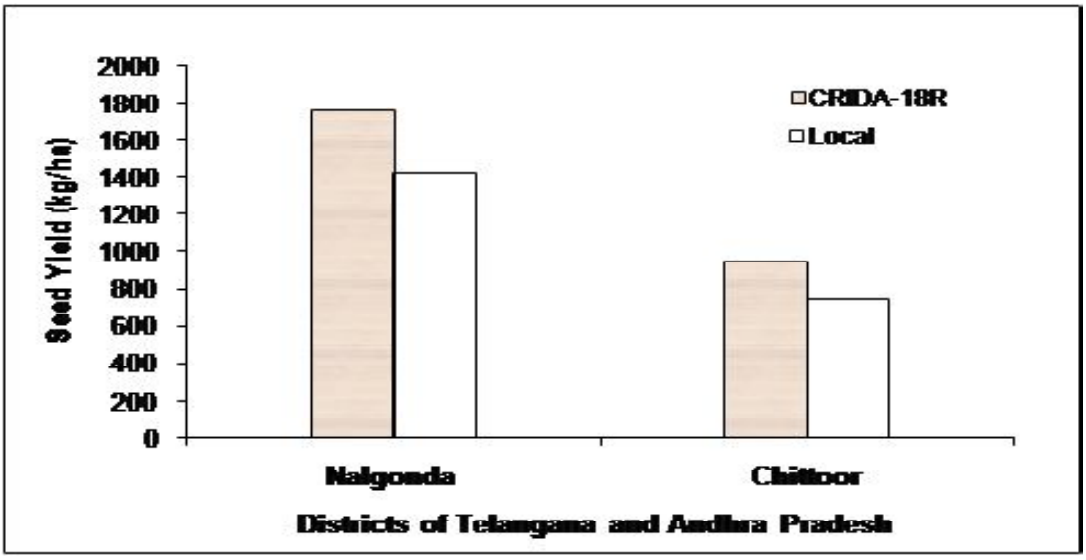


**Fig-3:** Comparative performance of CRIDA-18R over Local variety in the farmers' fields in districts one each of Telangana and Andhra Pradesh

yield performance (Figure 3) in both the regions. Overall performance of CRIDA 18 R at farmers' field was 27% higher than the local varieties.

**SWOT (Strengths, Weaknesses, Opportunities and Threats analysis) for the recommendation**: CRIDA 18 R horsegram variety sown during August in Hyderabad region has strengths of assured moderate amounts of rainfall with 3.33 lakh plant density per hectare responded up to 10+20 fertiliser dose (N and $P_2O_5$). Threats from pests and diseases may not be much as CRIDA-18R was observed to be tolerant to powdery mildew (<1%) and Yellow Mosaic Virus (YMV-9.2%) thus lowering the cost of plant protection (Kumar and Rodge, 2012)), while September sown crop may face deficit rainfall situation. Poor market price is a weakness and better rainfall improve yields is an opportunity.

Strength of the October sown crop in Tirupathi region, was receipt of sufficient quantities of rainfall (not very high) during crop growth period leading to higher yields, possibility of occurrence of rainless period during December and January was a threat while excess rainfall is also a threat for September sown crop and poor market price of the produce is a weakness.

## CONCLUSION

The optimum date of sowing time for Hyderabad region of Telangana State is second fortnight of August however, when the sowings were delayed, the yields could decline by 52% whereas in Tirupati region of Andhra Pradesh, sowings in second fortnight of October/ November could be recommended as it resulted in 62% higher yields due to the receipt of optimum quantum of North East monsoon rains avoiding wet spells with Sep sowing.

In the situation of demand driven delayed sowings, plant density of 3.33 lakh per hectare with or without fertilizer of 10+20 kg of N and $P_2O_5$ may be suitable to reap maximum yields in both the regions.

## REFERENCES

Annual Report. (2007-08).National Network Research Project on Arid Legumes, CAZRI, Jodhpur pp 279.

Directorate of Economics and Statistics. (2010). Department of Agriculture and Cooperation.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Wiley & Sons, Singapore.

Gowda, C. L. L., Srinivasan, S., Gaur, P. M. and Saxena, K. B. (2013). Enhancing the productivity and production of pulses in India. In: Climate Change and Sustainable Food Security (eds, Shetty)

Keshava, B.S., Halepyati, A.S., Pujari, B.T. and Desai, B.K. (2005). Influence of dry matter production and distribution on yield of horse gram as influenced by genotypes, plant densities and phosphorus levels. Karnataka *J of Agrl. Sciences*. **19**(4): 910-912.

Keshava, B.S., Halepyati, A.S., Pujari, B.T. and Desai, B.K. (2006). Yield and yield components of horse gram as influenced by genotypes, plant densities and phosphorus levels. Karnataka *J of Agrl. Sciences*. **19**(4): 777-780.

Kumar, D. and Rodge, A. B. (2012). Status, scope and strategies of arid legumes research in India- a review. *Journal of Food Legumes* **25**(4): 255-272.

Patil, N. D., Umarani, N.K., Shende, S.A., Manke, B.S., Kale, S.P. and Shingte, A.K.(1981). Improved crop production technology for drought prone areas of Maharashtra. Technical Bulletin, Dry Farming Research Station, Mahatma Phule Krishi Vidyapeeth, Solapur. Pp:

Patra, A.K. and Nayak, B.C. (2000). Response of horse gram (*Macrotyloma uniflorum*) to agronomic management practices. *Indian Journal of Agronomy*. **45**: 357-360.

Reddy, P. R., Maruthi, V. and Venkateswarlu, B. (2010). New variety of horsegram (*Macrotyloma uniflorum*) "CRIDA 18R" released for south India. The India *Journal of Agricultural Sciences* **80**(6): 477-481.

Yasin, J.K., Nizar, M.A., Raj Kumar, S., Verma, M., Verma,N., Pandey, S., Tiwari, S.K. and Radhamani, J. (2014). Existence of alternate defense mechanisms for combating moisture stress in horse gram. *Legume Research*. **37** (2): 145-154.