EFFECT OF HORSEGRAM (MACROTYLOMA UNIFLORUM LAM VERDEC) VARIETIES AND DIFFERENT ROW SPACING ON YIELD ATTRIBUTES AND YIELD

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Abstract: An field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during kharif season of 2011.There were twelve treatment combinations comprising four varieties (V_1 : AK 21, V_2 : AK 42, V_3 : GDHG 1 and V_4 : Local Cultivar) and three spacings (S_1 : 30 cm, S_2 : 45 cm, and S_3 : 60 cm). The results indicated that horsegram variety AK 42 significantly increased yield and yield attributes character viz., number of pods per plant, pod length (cm), number of seeds per pod and 100-seed weight (g), showed early flowering and maturity as compared to Local cultivar followed by AK 21 and GDHG 1. However, all varieties showed non-significant effect on harvest index (%). Seed yield was significantly influenced by different row spacing's. Row spacing of 30 cm produced higher seed yield (703 kg ha^{-1}) as compared to 45 and 60 cm, but it was at par with 45 cm row spacing. Haulm yield was observed significantly maximum at the same row spacing (2243 kg ha^{-1}). Thus from the present study, it seems quite logical to conclude that the horsegram variety AK 42 gave higher production followed by AK 42, AK 21 and GDHG 1 as compared to Local cultivar. Among different inter row spacing, 30 cm row spacing performed better as compared to wider row spacing's under North Gujarat agro-climatic conditions.

Key words: yield attributes, pods per plant, days to flowering, days to maturity, seed weight, seed yield, haulm yield, horsegram, spacing, varieties

Horsegram (Macrotyloma uniflorum Lam. Verdec) commonly known as "Kulthi" is traditional tropical grain legume, well known for its hardiness, adaptability to poor soil and adverse climatic conditions that are unsuitable for most other crops. Among over dozen of pulses crop grown in India, it ranks third in area covering 17.02 lakh hectare with an annual production of 7.19 lakh tonnes. The national average productivity of horsegram is (494 kg ha^{-1}). In Gujarat it is a minor pulse grown in 2160 hectare with average productivity of around 526 kg ha^{-1} (Kumar, 2007). To augment the crop yield per unit area, uses of high yielding varieties coupled with suitable crop geometry are considered to be the most vital factor. Sowing and early crop growth coincides with declining rainfall so crop establishment is often poor and yields are low. Horsegram is a 'neglected' crop and farmers' choice of varieties to grow is limited to poor-yielding landraces or to modern varieties for which access to seed is limited. Varieties find an important place among the factors known to augment crop production. In the last few years, due to intensive research efforts, number of excellent high yielding varieties viz., PHG 9, AK 21, AK 42, CRIDA 18 R, HPK 6, Maru Kulthi, Paiyur 1 and KBR 1 have been released which produced 900-1200 kg seed yield per hectare as compared to old varieties and maturity period has been curtailed to 85 days from 120 days (Kumar, 2008). These varieties have opened a new avenue to increase productivity of horsegram. Row Spacing has been the most important non-monetary input affecting the yield. The optimum plant stand per unit area is also important for securing higher yield. Suitable planting techniques are almost essential for interception of sunlight of each stratum of leaves, which in turn increase the rate of photosynthesis and consequently dry matter production. It would be essential to find out the proper row spacing for getting potential production. Adequate spacing provides better scope for growth and development of crop which ultimately reflects in higher yield.

Material and methods: A field experiment was conducted on plot number A-7 during kharif season of the year 2011 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha (North Gujarat). The experiment was laid out in randomized block design with factorial concept and replicated four times. There were twelve treatment combinations comprising four horsegram varieties (V_1: AK 21, V_2: AK 42, V_3: GDHG 1 and V_4: Local cultivar) and three levels of row spacing (S_1: 30 cm, S_2: 45 cm and S_3: 60 cm). The soil of experiment field was loamy sand in texture, low in nitrogen, medium in phosphorus and high in potash. Electrical conductivity was very low showing that the soil was free from salinity hazard. It is suitable to variety of crops of tropical and sub-tropical region. Recommended common fertilizer dose of 20: 40 kg N and P_2O_5 per hectare was applied as basal dose in the form of urea and diammonium phosphate in furrows for all the plots. The required quantity of healthy seeds of four varieties was treated with carbendazim. Then it was inoculated with Rhizobium

leguminoserum culture (@ 20 g kg^{-1}) and above treated seeds were kept under shade for two hours and then used for sowing in previously opened lines in each plot. The crop was sown keeping inter-row spacing as per treatments and intra row spacing of 10 cm using seed rate of 12 kg ha^{-1} for 30 cm row spacings, while 8 kg and 6 kg per hectare for 45 cm and 60 cm row spacings, respectively. The data pertaining to yield and yield attributes were evaluated.

Results and discussion: Effect of varieties : Variety AK 42 recorded significantly the highest number of pods per plant (39.6), number of seeds per pod (4.7), pod length (4.7 cm) and 100-seed weight (3.78 g) as compared to Local cultivar, but it remained at par with AK 21 and GDHG 1.Local variety took significantly more number of days to flowering (49 day) and days to maturity (80 day) than that of GDHG 1, AK 21 and AK 42.Differences in seed and haulm yield were significant. Variety AK 42 registered the highest seed (739 kg ha^{-1}) and haulm (2204 kg ha^{-1}) yield as compared to Local cultivar, but it was at par with AK 21 and GDHG 1.

A perusal of data revealed that the differences in number of pods per plant were significant due to varieties. Variety AK 42 (39.7) being at par with AK 21 (37.9) and GDHG 1 (36.9) produced significantly higher pods per plant than Local cultivar (29.7).

It can be clearly seen that significantly higher pod length was observed in AK 42 variety (4.7 cm) as compared to Local cultivar (4.4 cm). However, the same variety was found at par with AK 21 (4.6 cm) and GDHG 1 (4.5 cm). The results revealed that the differences in number of seeds per pod were significant due to different varieties. Variety AK 42 being at par with AK 21 (4.4) and GDHG 1 (4.4) gave significantly higher number of seeds per pod (4.7) than Local cultivar (3.9). It is seen from the data that the differences in days to 50 per cent flowering were found significant due to varieties. Local cultivar took significantly more number of days to 50 per cent flowering (49 days) than rest of the varieties.

It is seen from the data that the differences in days to maturity was found significant due to varieties. Local cultivar took significantly more number of days to maturity (80 days) than that of GDHG 1 (78 days), AK 21 (77 days) and AK 42 (76 days).

It is revealed from the data that different varieties had significant influence on 100- seed weight. Variety AK 42 being at par with AK 21 (3.74 g) and GDHG 1 (3.71 g) recorded significantly the highest 100-seed weight (3.78 g) as compared to Local cultivar (3.48 g).

The data presented in Table 3 revealed that horsegram varieties differed significantly in their yield performance. Significantly the highest seed yield (739 kg ha^{-1}) was produced by variety AK 42 as compared to Local cultivar (509 kg ha^{-1}) and the same was at par with AK 21 (680 kg ha^{-1}) and GDHG 1 (668 kg ha^{-1}).

Haulm yield of horsegram was significantly affected by different varieties. Significantly maximum haulm yield (2204 kg ha^{-1}) was recorded with variety AK 42 as compared to Local cultivar (1674 kg ha^{-1}) and was found at par with AK 21 (2115 kg ha^{-1}) and GDHG 1 (2106 kg ha^{-1}).

Different varieties did not show any significant influence on harvest index value. However, variety AK 42 recorded numerically higher harvest index (25.1 %) followed by AK 21 (24.5 %) and GDHG 1 (24.3 %).

Discussion: Significantly the number of pods per plant and pod length altered due to different varieties (Table 1). Variety AK 42 gave 33.3, 6.9 and 4.5 per cent higher number of pods per plant as compared to Local cultivar, GDHG 1 and AK 21, respectively. It also gave maximum pod length (4.7 cm) as compared to rest of the varieties. Such types of varietal differences were also reported by Nagaraju et al., (1995), Parameswarappa and Kumar (2002), Jain and Sodani (2003), Prakesh et al., (2008) in horsegram, Patel et al., (2005), Kabir and Sarkar (2008), Ahamed et al., (2011) in mungbean and Yadav et al., (2010) in clusterbean. The resulted presented in Table 1, indicated that number of seeds per pod was significantly influenced by different varieties. Variety AK 42 gave 20.5, 6.8 and 6.8 per cent higher number of seeds per pod as compared to Local cultivar, GDHG 1 and AK 21,respectively. These results are in conformation with the findings of Parameswarappa and Kumar (2002), Jain and Sodani (2003), Prakesh et al., (2008) in horsegram, Patel et al., (2005) Kabir and Sarkar (2008) in mungbean, Ahamed et al., (2011) and Yadav et al., (2010) in clusterbean. Further, data also revealed that number of days to 50 per cent flowering was significantly influenced by different varieties (Table 2). Variety AK 42 flowered 2, 4 and 7 days earlier than AK 21, GDHG1 and Local cultivar, respectively. This effect might be due to the combined effect of genetic variation between varieties and environ- mental influence. Such varietal differences were in conformity with research work reported from Nagaraju et al., (1995), Prakash et al., (2002), Parameswarappa and Lamani (2002), Jain and Sodani (2003), Virk et al., (2006) in horsegram and Chuadhary et al., (2007) in clusterbean.

The result presented in Table 2 indicated that number of days to 80 per cent maturity was significantly influenced by different varieties. Variety AK 42 matured earlier than AK 21, GDHG 1 and Local cultivar by 1, 2 and 4 days, respectively. This effect might be due to the combined effect of genetic variation between varieties and environmental influence. Such varietal differences were in conformity with research work reported from Singh and Singh (1992), AICRPAL (1999-2000),

Parameswarappa and Lamani (2002), Jain and Sodani (2003), Phogat et al., (2005), Sodani et al., (2006) Virk et al., (2006) Prakash et al., (2008) in horsegram and Chuadhary et al., (2007) in clusterbean.

The result presented in Table 3 indicated that different varieties had differences in seed yield. Variety AK 42 produced the highest seed yield (739 kg ha^{-1}) which was higher to tune of 8.7, 10.6 and 45.2 per cent over AK 21, GDHG 1 and Local cultivar, respectively. The higher seed yield observed in AK 42 might be due to genetic makeup and significantly higher values of yield attributing characters like number of pods per plant, seeds per pod, number of branches per plant, pod length and 100-seed weight. The results corroborate the findings of Singh and Singh (1992), Nagaraju et al., (1995), AICRPAL (1999-2000), Prakash et al., (2002), Parameswarappa and Lamani (2002), Jain and Sodani (2003), Prakash et al., (2004), and Phogat et al., (2005), Sodani et al., (2006), Keshava et al., (2007), Prakash et al., (2008), Reddy et al., (2010) in horsegram, Kandpal et al., (2006) in mothbean and Chuadhary et al., (2007) in clusterbean. The data presented in Table 3 indicated that the haulm yield was influenced by the highest haulm yield (2204 kg ha^{-1}). It was 4.2, 4.7 and 31.7 per cent more than the varieties AK 21, GDHG 1 and Local cultivar. Maximum haulm yield could be attributed to appreciably higher number of branches per plant recorded in this variety. These results are in conformity with those reported by Prakash et al., (2002), Parameswarappa and Lamani (2002), Jain and Sodani (2003), Keshava et al., (2007), Prakash et al., (2008) in horsegram, Kandpal et al., (2006) in mothbean, Chuadhary et al., (2007) in clusterbean.

The result presented in Table 3 indicated that 100-seed weight was significantly influenced by different varieties. Variety AK 42 gave significantly higher 100-seed weight (3.78 g) to the tune of 1.1, 1.9 and 8.6 per cent over AK 21, GDHG 1 and Local cultivar, respectively. These results are in conformity with those reported by Jain and Sodani (2003) in horsegram and Ahamed et al., (2011) in mungbean.

Data presented in forgoing chapter (Table 3) indicated that differences in harvest index due to different varieties were found non-significant. However, variety AK 42 gave numerically higher harvest index (25.1 %) to the tune of 2.5, 3.3 and 5.9 per cent over varieties AK 21, GDHG 1 and Local cultivar, respectively.

Effect of row spacing: An appraisal of data presented in Table 1 revealed that different levels of spacing had non-significant effect with respect to number of pods per plant. Among different spacings, wider row spacing (60 cm) recorded numerically maximum number of pods per plant (36.8) followed by 30 cm (35.2) and 45 cm (36.1). An appraisal of data presented in Table 1 revealed that the effect of different levels of spacing was found non-significant with respect to pod length. However, maximum pod length (4.6 cm) observed under 60 cm row spacing followed by 45 cm (4.5 cm) and 30 cm (4.5 cm).

The data presented in Table 1 indicated that different levels of spacings had no significant influence on number of seeds per pod in horsegram. The average number of seeds per pod recorded under different spacings, i.e. 30 cm, 45 cm and 60 cm treatments were 4.2, 4.4 and 4.5, respectively.The results further revealed that the levels of spacing did not produce any significant effect on days to 50 per cent flowering.Examination of data indicated those days to maturity was not affected by the different levels of spacing. From the data given in Table 3, it is seen that differences in 100-seed weight due to different levels of spacing were found non-significant. The widest row spacing (60 cm) numerically gave the highest 100-seed weight (3.71 g) followed by 45 cm (3.69 g) and 30 cm (3.61 g). Mean data presented in Table 3, revealed that seed yield was significantly affected due to different spacing. The crop when sown at 30 cm row spacing, recorded significantly higher seed yield (706 kg ha^{-1}) over 60 cm (601 kg ha^{-1}) and was statistically at par with 45 cm (640 kg ha^{-1}) . The results indicated that the effect of different spacings on haulm yield of horsegram was found significant. When crop was sown at 30 cm row spacing, it recorded maximum haulm yield (2243 kg ha^{-1}) and was significantly superior over other wider spacings of 45 cm (1987 kg ha^{-1}) and 60 cm (1845 kg ha^{-1}). Data recorded on harvest index revealed that the differences due to spacings were non-significant. Numerically maximum harvest index was recorded with 60 cm row spacing (24.7 %) followed by 45 cm (24.4 %) and 30 cm (24.1 %).

Discussion: The data further (Table 1) revealed that the number of pods per plant at harvest was not significantly influenced by different levels of row spacing. However, 60 cm row spacing (36.8) showed numerically higher number of pods per plant over 30 cm (35.2) and 45 cm (36.1). The highest number of pods per plant was recorded at 60 cm row spacing. This might be due to the result of more space available per plant which reflected in efficient utilization of natural resources like, water, nutrient and light which contributed of more number of pods per plant. The results are in accordance with the findings of the Kandpal et al., (2006) in mothbean, Kabir and Sarkar (2008) in mungbean and Yadav et al., (2010) in clusterbean. The result further indicated that different levels of row spacing failed to exert any significant effect on number of seeds per pod and pod length. Similar results were also reported by Singh and Singh (1992), Nagaraju et al., (1995), Jain and Sodani (2003) in horsegram and Kabir and Sarkar (2008) in mungbean.

The result (Table 2) further indicated that different levels of row spacing failed to exert any significant effect on days to 50 per cent flowering and 80 per cent maturity. This might be because of little variation in micro climate under different levels of spacing. Similar results were also reported by Singh and Singh (1992), and Jain and Sodani (2003) in horsegram. The data presented in Table 3 revealed that the seed yield was significantly influenced by different levels of row spacing. In general, increasing trend in seed yield was observed with decreasing levels of spacing. Narrow row spacing of 30 cm produced higher seed yield over rest of the levels of spacing. The seed yield obtained with the narrow spacing (30 cm) was higher by 10.3 and 17.5 per cent than wider spacing of 45 cm and 60 cm, respectively. The higher seed yield with 30 cm row spacing might be due to accommodation of number of plants more over 45 and 60 cm row spacings covering the land more uniformly and protecting the loss of water through evaporation. The effect of narrow spacing has been explained by the fact that the close canopy may intercept solar radiation to the greater extent, thereby increasing photosynthesis (Patel et al., 1985 in groundnut). The results obtained in this study are in conformity with those obtained by Chandarnath and Hosmani (1994), Nagaraju et al., (1995), Jain and Sodani (2003), Sodani et al., (2006), Keshava et al., (2007), Reddy et al., (2010) in horsegram, Patel et al., (2005) in mungbean, Kandpal et al., (2006) and Patel et al., (2010) in mothbean. Results (Table 3) further revealed that different row spacing significantly influenced the haulm yield. In general, increasing trend in haulm yield was observed with decreasing levels of spacing. Narrow row spacing of 30 cm produced higher haulm yield over rest of the levels of spacing.

The haulm yield obtained with the narrow spacing (30 cm) was higher by 12.9 and 21.6 per cent than wider spacing of 45 cm and 60 cm. This may be attributed to the increased plant population per unit area and taller plants under narrow row spacing. These results are in accordance with the findings of Chandarnath and Hosmani (1994), Jain and Sodani (2003), Keshava et al., (2007) in horsegram, Patel et al., (2005) in mungbean, Kandpal et al., (2006) and Patel et al., (2010) in mothbean.

It was observed that 100-seed weight (Table 3) was not significantly influenced due to different spacings. Row spacing of 30 cm, 45 cm and 60 cm recorded 3.63, 3.69 and 3.71 g 100-seed weight, respectively. The highest 100-seed weight was recorded at 60 cm row spacing. This was due to reflection of yield attributing characters usually achieved well under optimum availability of space, where competition within plant was minimum. Similar results were also reported by Jain and Sodani (2003) in horsegram.

Data presented in foregoing chapter (Table 3) indicated that differences in harvest index due to different levels of spacing were found non-significant. 60 cm row spacing treatment exhibited the highest harvest index was due to numerically higher proportion of seed yield and lower vegetative yield in this treatment than other spacing treatments. The results obtained in this study were in conformity with those obtained by Kandpal et al., (2006) in mothbean.

Conclusion: In light of the results obtained from present investigation, it is concluded that varieties AK 42, AK 21 and GDHG 1 found suitable for getting higher production. Among the spacing, 30 cm inter row spacing for horsegram was found optimum for getting higher yield and net profit in kharif season on loamy sand soil under North Gujarat agro- climatic conditions.

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Table 1. Number of pods per plant, pod length and no. of seeds per pod of horse gram as influenced by varieties and sapcings.

Treatment	No. of pods per plant	Pod length (cm)	No. of seeds per pod
Variety			
V_1 : AK 21	37.9	4.6	4.4
V_2 : AK 42	39.6	4.7	4.7
V_3 : GDHG 1	36.9	4.5	4.4
V_4: Local cultivar	29.7	4.4	3.9
S. Em. ±	1.11	0.07	0.10
C.D. (P=0.05)	3.2	0.19	0.3
Spacing (cm)			
S_1 : 30	35.2	4.5	4.2
S_2 : 45	36.1	4.5	4.4
S_3 : 60	36.8	4.6	4.5
S. Em.±	0.96	0.06	0.09
C.D. (P=0.05)	NS	NS	NS
Interaction	NS	NS	NS
C.V.%	10.7	5.1	8.1

Table 2. Days to 50 per cent flowering and days to 80 per cent maturity of horsegram as influenced by varieties and sapcings

Treatment	Days to 50 per cent flowering	Days to 80 per cent maturity
Variety		
V_1 : AK 21	44	77
V_2 : AK 42	42	76
V_3 : GDHG 1	46	78
V_4: Local cultivar	49	80
S. Em. ±	0.6	0.6
C.D.(P=0.05)	1.9	1.8
Spacing (cm)		
S_1 : 30	44	77
S_2 : 45	45	78
S_3 : 60	46	79
S. Em.±	0.6	0.6
C.D. (P=0.05)	NS	NS
Interaction	NS	NS
C.V.%	5.0	2.8

Table 3. Hundred seed weight, seed yield, haulm yield and harvest index of horsegram as influenced by varieties and spacings

Treatment	100-seed weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
Variety				
V_1 : AK 21	3.74	680	2115	24.5
V_2 : AK 42	3.78	739	2204	25.1
V_3 : GDHG 1	3.71	668	2106	24.3
V_4: Local cultivar	3.48	509	1674	23.7
S. Em. ±	0.04	26.4	87.9	1.15
C.D. (P=0.05)	0.12	76	253	NS
Spacing (cm)				
S_1 : 30	3.63	706	2243	24.1
S_2 : 45	3.69	640	1987	24.4
S_3 : 60	3.71	601	1845	24.7
S. Em.±	0.04	22.9	76.1	1.0
C.D. (P=0.05)	NS	66	219	NS
Interaction	NS	NS	NS	NS
C.V.%	3.8	14.1	15.0	16.4

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