# EFFECT OF SPACING AND NUTRIENT MANAGEMENT ON NUTRIENT CONTENT AND UPTAKE OF DHAINCHA (*Sesbania aculeata* L.) UNDER SOUTH GUJARAT CONDITION

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***ABSTRACT***

***A field experiment was conducted during rabi season of the year 2010-2011 at College Farm, Navsari Agricultural University, Navsari (Gujarat) to study "Response of dhaincha (Sesbania aculeata L.) to spacing and nutrient management under South Gujarat condition". Sixteen treatment combinations consisting of two levels of spacing, 45 cm x 10 cm and 60 cm x 10 cm, two levels of inorganic fertilizers, 75 per cent RDF and 100 per cent RDF, and four levels of biofertilizer, no biofertilizer, Rhizobium (Azorhizobium caulinodans), Phosphate solubilizing bacteria (Bacillus coagulans) and combination of Rhizobium (Azorhizobium caulinodans) + Phosphate solubilizing bacteria (Bacillus coagulans) were evaluated in split-split plot design with three replications. The result revealed that rabi dhaincha grown for seed production with 60 ×10 cm spacing and fertilized with 100 per cent RDF (25-50 kg NP/ha) along with Rhizobium (Azorhizobium caulinodans) @ 10 ml/kg seed + phosphate solubilizing bacteria (Bacillus coagulanns) @ 10 ml/kg seed for seed inoculation under South Gujarat condition for getting higher nutrient uptake, yield and monetary returns with sustainable soil health.***

***KEY WORDS:*** *Dhaincha, nutrient, content, management, uptake*

## INTRODUCTION

Dhaincha (*Sesbania* species) is a valuable crop of the summer season (March - July) with multi-various uses. It finds use in green manuring, soil reclamation, as an animal feed and in agro-forestry. Some species are even known to control weeds and the seeds of still others have valuable properties for gum production. Productivity and nutrient composition biomass production of dhaincha has been reported to be 4807 kg/ha and N in the aboveground biomass to be 97 kg/ha (Creamer and Baldwin, 2000). *Sesbania aculeata* yielded in the range of 1 to 1.5 t/ha of seeds. Proper spacing provides sufficient interception of light and satisfactory absorption of nutrients and water from the soil due to the proper development of root system and results in higher crop yield of *Sesbania aculeata*. Nutrient management is an age old concept practice in traditional agriculture because of the low nutrient turns over in soil plant system (Meelu and Singh, 1991). Nutrient management approach involving inorganic fertilizers, biological sources and organic manure will go a long way in building soil fertility on sustainable basis, since the system will supply almost all the nutrients in a judicious way, besides increasing the nutrient use efficiency and improving the physico-chemical properties of soil. Dhaincha being a leguminous crop utilizes atmospheric nitrogen through symbiotic nitrogen fixation to meet a major part of its nitrogen requirement. The seed inoculation with proper strain of biofertilizer is the low cost input for enhancing crop yields. Phosphorus solubilizes the native phosphorus by the secretion of organic acid. Inoculation with phosphate solubilising bacteria alone increased the grain yield of dhaincha by about 8.3 per cent than that of no inoculation. (Meena *et al.,* 2001). Considering the above facts and views, the present experiment was planned to study the effect of spacing and nutrient management on nutrient content and uptake of dhaincha (*Sesbania aculeata* L.) under South Gujarat condition in *rabi* season.

## MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of the year 2010-2011 at College Farm, Navsari Agricultural University, Navsari (Gujarat) to study "Effect of spacing and nutrient management on nutrient content and uptake of dhaincha (*Sesbania aculeata* L.) under South Gujarat condition". The soil of the experimental field was clayey in texture, low in available nitrogen (232.50 kg/ha), medium in available phosphorus (32.00 kg/ha) and fairly rich in available potassium (350.00 kg/ha) with 7.8 soil pH. Sixteen treatment combinations consisting of two levels of spacing as main plot i.e., $S_1$: 45 cm x 10 cm and $S_2$: 60 cm x 10 cm, two levels of inorganic fertilizers as sub plot viz., 75 per cent RDF ($F_1$) and 100 per cent RDF ($F_2$) and four levels of biofertilizer as sub-sub plot viz., No biofertilizer ($B_0$), *Rhizobium* (*Azorhizobium caulinodans*) ($B_1$), Phosphate solubilizing bacteria (*Bacillus coagulans*) ($B_2$) and *Rhizobium* (*Azorhizobium caulinodans*) + Phosphate solubilizing bacteria (*Bacillus coagulans*) ($B_3$) were evaluated in split-split plot design with three replications. Recommended dose of fertilizer (RDF) was 25: 50: 00 NPK kg/ha. Other cultural practices and plant protection measures were taken as per recommendations. The data on seed and straw yield were recorded from each net plot and converted on hectare basis. Representative samples from seed and straw were taken separately for the estimation of N, P and K contents from each treatment from all the three replications. The samples were sun dried for a week and then oven dried at $70^0$C temperature for 24 hours and grinded into powder by mechanical grinder. The N, P and K contents were determined by using Modified Kjeldahl's method, Wet digestion (Diacid) Venedomolybdic yellow colour method and Wet digestion (Diacid) Flame photometric method, respectively, given by Jackson (1967). The uptake values of nitrogen (N), phosphorus (P), and potassium (K) for seed/stover were worked out by following formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in seed/stover (\%)} \times \text{Seed/stover yield (kg/ha)}}{100}$$

The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1967).

## RESULT AND DISCUSSION

### *Effect of Spacing*

The data of seed/stover yield (kg/ha) and economics of *rabi* dhaincha as influenced by various treatments were presented in Table 1. the results revealed significantly the highest seed and straw yield with $S_2$ (60 cm) as compared to $S_1$ (45 cm). These findings were corroborated the results of Ulemale and Shivankar (2003) and Lamani *et al*. (2004) in sunnhemp and Kumar *et al*. (2005) in Dhaincha with respect to seed yield and Yadav (2003) in cowpea with respect to seed and straw yield. Maximum net return of ₹. 88684/ha and BCR value of 5.4 was recorded under $S_2$ (60 cm) spacing over $S_1$ (45 cm), which recorded net return of ₹. 79811/ha with BCR value of 4.7 (Table 1). This was due to higher yield of seed and straw registered under $S_2$ (60 cm) spacing. Similar results were also reported by Kumar (2004) in cowpea. The N, P and K content (Table 2) in seed and straw were non-significant due to spacing levels, but nutrient uptake (N, P and K content) by seed and straw (Table 3) and total nutrient uptake (Table 4) were significantly influenced due to spacing levels. Higher nutrient uptake recorded under increased spacing levels (60 cm) because of higher seed and straw yield. These results are in conformity with those of Dwangan *et al*. (1992) and Sathyamoorthi *et al*. (2008) in greengram. Different spacing treatments failed to show any significant effect on available nutrient status of soil after harvest of dhaincha crop (Table 5). However, available nutrient status of soil after harvest of crop was increased as compared to initial nutrient status.

***Effect of inorganic fertilizer***

Treatment receiving 100 per cent RDF ($F_2$) produced significantly the highest seed yield (1520 kg/ha) over other treatment $F_1$. The results were supported by the findings of Rengalakshmi and Purshothman (1999) in dhaincha, Kumar *et al.* (2005) and Shastri *et al.* (2007) in sunnhemp and Sharma *et al.* (2003) in greengram. Straw yield remained unaffected by various inorganic fertilizers (Table 1). However, numerically increase in straw yield with application of 100 per cent RDF ($F_2$) was observed as compared to 75 per cent RDF ($F_1$). The net return of ₹. 86645/ha with BCR value of 4.8 was obtained under treatment receiving 100 per cent RDF ($F_2$) as against the net return of ₹. 80018/ha and BCR of 4.5 with 75 per cent RDF ($F_1$) treatment (Table 1). This was due to higher yield in $F_1$, ultimately reflected into higher net realization and BCR. Similar results were also reported by Ambhore (2004) in greengram and Kumar *et al*. (2005) in sunnhemp. The N, P and K content (Table 2) in seed and straw were non-significant due to inorganic fertilizer levels, but the N, P and K uptake in seed and straw (Table 3) as well as total nutrient uptake (Table 4) were significantly influenced by inorganic fertilizers. Significantly the highest N, P and K uptake by seed and straw and total nutrient uptake were recorded under treatment receiving 100 per cent RDF ($F_2$). This was due to synergistic effect of NPK fertilization, better development of root and shoot resulted into higher N, P and K uptake. These results are in conformity with those of Kumawat and Khangarot (2002) in clusterbean and Ambhore (2004) in greengram. The effect of various levels of inorganic fertilizers on available nitrogen, phosphorus and potassium (Table 5) was non-significant.

***Effect of biofertilizer***

Significantly the highest seed yield (1729 kg/ha) and straw yield (9071 kg/ha) were recorded with *Rhizobium* (*Azorhizobium caulinodans*) + phosphate solubilizing bacteria (*Bacillus coagulans*) inoculation ($B_3$) over no inoculation ($B_0$). This might be due to significant and progressive effect of *Rhizobium* (*Azorhizobium caulinodans*) + phosphate solubilizing bacteria (*Bacillus coagulans*) inoculation (Table 1). These results corroborated the findings of Jain and Singh (2003) in gram and Nagar and Menna (2004) in clusterbean. The highest net return of ₹. 101270/ha with BCR value of 6.0 was obtained with *Rhizobium* (*Azorhizobium caulinodans*) + phosphate solubilizing bacteria (*Bacillus coagulans*) inoculation ($B_3$) (Table 1). This was due to comparatively better increase in yield with $B_3$ (1729 kg/ha) treatment over $B_2$ (1546 kg/ha), $B_1$ (1361 kg/ha) and $B_0$ (1236 kg/ha). These results are in accordance with the findings of Bhalu *et al*. (1995) in blackgram and Singh *et al*. (2004) in legumes. The content of N, P and K in seed as well as in straw was non-significant (Table 2). However, uptake of these nutrients was affected significantly due to different biofertilizer treatments (Table 3 & 4). In all these cases (N, P, K uptake in seed and straw and total nutrient uptake), treatment *Rhizobium* (*Azorhizobium caulinodans*) + phosphate solubilizing bacteria (*Bacillus coagulans*) inoculation ($B_3$) showed superiority over rest of these biofertilizer treatments viz., Phosphate solubilizing bacteria (*Bacillus coagulans*) ($B_2$), *Rhizobium* (*Azorhizobium caulinodans*) ($B_1$) and no biofertilizer ($B_0$). This increased uptake by seed, straw and total nutrient might be due to increased yield of seed and straw under treatment (B3). Similar results are also observed by Nagaraju and Nanjundappa (1996) in cowpea and Ram and Dixit (2000) in greengram. Biofertilizer failed to show any significant effect on available N, $P_2O_5$ and $K_2O$ status of soil after harvest of dhaincha crop 3.

## CONCLUSION

From the results, it cane be concluded that *rabi* dhaincha (var. Local) should be grown with 60 ×10 cm spacing and fertilized with 100 per cent RDF (25-50 kg NP/ha) along with *Rhizobium* + phosphate solubilizing bacteria seed inoculation under South Gujarat condition for getting higher nutrient uptake, yield and monetary returns with sustainable soil health.

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**Table 1: Seed/stover yield (kg/ha) and economics of *rabi* dhaincha as influenced by various treatments.**

| Treatment | Seed Yield (kg/ha) | Stover Yield (kg/ha) | Gross Realization (₹./ha) | Cost of Cultivation (₹./ha) | Net Realization (₹./ha) | BCR |
|---|---|---|---|---|---|---|
| **Spacing (S)** | | | | | | |
| $S_1$ = 45cm | 1403 | 8053 | 96459 | 16648 | 79811 | 4.7 |
| $S_2$ = 60cm | 1533 | 8383 | 105017 | 16333 | 88684 | 5.4 |
| S. Em. ± | 21.15 | 115.25 | - | - | - | - |
| C.D. (P=0.05) | 128.69 | 204.24 | - | - | - | - |
| C.V. % | 7.06 | 6.37 | - | - | - | - |
| **Inorganic Fertilizer (F)** | | | | | | |
| $F_1$ = 75 % RDF | 1416 | 8335 | 97558 | 17540 | 80018 | 4.5 |
| $F_2$ = 100 % RDF | 1520 | 8665 | 104483 | 17838 | 86645 | 4.8 |
| S. Em. ± | 22.71 | 119.12 | - | - | - | - |
| C.D. (P=0.05) | 89.20 | NS | - | - | - | - |
| C.V. % | 7.58 | 7.20 | - | - | - | - |
| **Biofertilizer (B)** | | | | | | |
| $B_0$ = No Bio fertilizer | 1236 | 8100 | 86024 | 16648 | 69376 | 4.1 |
| $B_1$ = *Rhizobium* | 1361 | 8460 | 94223 | 16698 | 77525 | 4.6 |
| $B_2$ = PSB | 1546 | 8794 | 106241 | 16698 | 89543 | 5.3 |
| $B_3$ = *Rhizobium* + PSB | 1729 | 9071 | 118018 | 16748 | 101270 | 6.0 |
| S. Em. ± | 30.33 | 124.70 | - | - | - | - |
| C.D. (P=0.05) | 88.54 | 220.95 | - | - | - | - |
| **Interaction** | | | | | | |
| S X F | NS | NS | - | - | - | - |
| S X B | NS | NS | - | - | - | - |
| F X B | NS | NS | - | - | - | - |
| S X F X B | NS | NS | - | - | - | - |
| C.V. % | 7.16 | 5.32 | - | - | - | - |

***Selling price of Dhaincha : Seed – ₹. 63/kg and Stover – ₹. 1.0/kg***

**Table 2: Nutrient (N, P and K) content (%) in rabi dhaincha as influenced by various Treatments**

| Treatment | N Content (%) | | P Content (%) | | K Content (%) | |
|---|---|---|---|---|---|---|
| | **Seed** | **Stover** | **Seed** | **Stover** | **Seed** | **Stover** |
| **Spacing (S)** | | | | | | |
| $S_1$ = 45cm | 3.052 | 0.821 | 0.142 | 0.098 | 1.093 | 0.602 |
| $S_2$ = 60cm | 3.106 | 0.840 | 0.143 | 0.100 | 1.099 | 0.606 |
| S. Em. ± | 0.020 | 0.004 | 0.001 | 0.001 | 0.007 | 0.002 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS |
| C.V. % | 3.41 | 2.38 | 3.23 | 2.96 | 3.20 | 2.83 |
| **Inorganic Fertilizer (F)** | | | | | | |
| $F_1$ = 75 % RDF | 3.089 | 0.827 | 0.142 | 0.097 | 1.096 | 0.602 |
| $F_2$ = 100 % RDF | 3.142 | 0.839 | 0.146 | 0.102 | 1.110 | 0.611 |
| S. Em. ± | 0.055 | 0.010 | 0.002 | 0.001 | 0.012 | 0.003 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS |
| C.V. % | 7.53 | 5.04 | 5.65 | 6.13 | 4.57 | 3.45 |
| **Biofertilizer (B)** | | | | | | |
| $B_0$ = No Bio fertilizer | 3.020 | 0.810 | 0.140 | 0.091 | 1.090 | 0.601 |
| $B_1$ = *Rhizobium* | 3.056 | 0.826 | 0.142 | 0.099 | 1.097 | 0.603 |
| $B_2$ = PSB | 3.051 | 0.818 | 0.143 | 0.097 | 1.086 | 0.597 |
| $B_3$ = *Rhizobium* + PSB | 3.131 | 0.847 | 0.145 | 0.101 | 1.014 | 0.611 |
| S. Em. ± | 0.030 | 0.009 | 0.001 | 4.80 | 0.007 | 0.005 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS |
| **Interaction** | | | | | | |
| S X F | NS | NS | NS | NS | NS | NS |
| S X B | NS | NS | NS | NS | NS | NS |
| F X B | NS | NS | NS | NS | NS | NS |
| S X F X B | NS | NS | NS | NS | NS | NS |
| C.V. % | 4.08 | 4.83 | 4.14 | 4.80 | 2.65 | 3.19 |

**Table 3: Nutrient (N, P and K) uptake (kg/ha) in rabi dhaincha as influenced by various treatments**

| Treatment | N Uptake (kg/ha) | | P Uptake (kg/ha) | | K Uptake (kg/ha) | |
|---|---|---|---|---|---|---|
| | Seed | Stover | Seed | Stover | Seed | Stover |
| **Spacing (S)** | | | | | | |
| $S_1$ = 45cm | 42.82 | 66.11 | 1.992 | 7.89 | 15.33 | 48.48 |
| $S_2$ = 60cm | 47.64 | 70.42 | 2.193 | 8.38 | 16.85 | 50.80 |
| S. Em. ± | 0.70 | 0.23 | 0.034 | 0.021 | 0.23 | 0.28 |
| C.D. (P=0.05) | 4.23 | 1.40 | 0.099 | 0.060 | 0.68 | 0.80 |
| C.V. % | 1.10 | 7.29 | 12.80 | 5.51 | 11.37 | 12.00 |
| **Inorganic Fertilizer (F)** | | | | | | |
| $F_1$ = 75 % RDF | 43.74 | 68.93 | 2.011 | 8.085 | 15.52 | 50.17 |
| $F_2$ = 100 % RDF | 47.78 | 72.70 | 2.220 | 8.838 | 16.88 | 52.94 |
| S. Em. ± | 0.51 | 0.20 | 0.034 | 0.044 | 0.23 | 0.23 |
| C.D. (P=0.05) | 1.76 | 0.65 | 0.098 | 0.13 | 0.67 | 0.68 |
| C.V. % | 7.69 | 5.11 | 10.32 | 9.49 | 9.26 | 8.27 |
| **Biofertilizer (B)** | | | | | | |
| $B_0$ = No Bio fertilizer | 37.35 | 65.61 | 1.731 | 7.370 | 13.48 | 48.68 |
| $B_1$ = *Rhizobium* | 41.60 | 69.88 | 1.933 | 8.370 | 14.93 | 51.01 |
| $B_2$ = PSB | 47.19 | 71.93 | 2.211 | 8.530 | 16.79 | 52.50 |
| $B_3$ = *Rhizobium* + PSB | 53.83 | 76.83 | 2.507 | 9.162 | 17.53 | 55.42 |
| S. Em. ± | 0.512 | 0.33 | 0.027 | 0.040 | 0.17 | 0.21 |
| C.D. (P=0.05) | 1.49 | 0.98 | 0.077 | 0.11 | 0.50 | 0.62 |
| **Interaction** | | | | | | |
| S X F | NS | NS | NS | NS | NS | NS |
| S X B | NS | NS | NS | NS | NS | NS |
| F X B | NS | NS | NS | NS | NS | NS |
| S X F X B | NS | NS | NS | NS | NS | NS |
| C.V. % | 7.26 | 8.59 | 8.14 | 8.54 | 6.89 | 7.60 |

**Table 4: Total N, P and K uptake (kg/ha) as influenced by various treatments in *rabi* dhaincha**

| Treatment | Total Nutrient Uptake (kg/ha) | | |
|---|---|---|---|
| | N (kg/ha) | P (kg/ha) | K (kg/ha) |
| **Spacing (S)** | | | |
| $S_1$ = 45cm | 109.0 | 10.0 | 64.0 |
| $S_2$ = 60cm | 118.0 | 10.5 | 67.6 |
| S. Em. ± | 0.91 | 0.054 | 0.50 |
| C.D. (P=0.05) | 5.54 | 0.16 | 1.43 |
| C.V. % | 10.21 | 8.36 | 11.35 |
| **Inorganic Fertilizer (F)** | | | |
| $F_1$ = 75 % RDF | 112.0 | 10.2 | 65.0 |
| $F_2$ = 100 % RDF | 120.0 | 11.5 | 69.0 |
| S. Em. ± | 0.62 | 0.06 | 0.35 |
| C.D. (P=0.05) | 2.02 | 0.18 | 1.00 |
| C.V. % | 5.70 | 7.86 | 6.46 |
| **Biofertilizer (B)** | | | |
| $B_0$ = No Bio fertilizer | 103.0 | 9.6 | 62.0 |
| $B_1$ = *Rhizobium* | 111.0 | 10.1 | 66.0 |
| $B_2$ = PSB | 119.0 | 10.3 | 69.0 |
| $B_3$ = *Rhizobium* + PSB | 130.0 | 11.6 | 72.0 |
| S. Em. ± | 0.66 | 0.05 | 0.28 |
| C.D. (P=0.05) | 1.93 | 0.16 | 0.80 |
| **Interaction** | | | |
| S X F | NS | NS | NS |
| S X B | NS | NS | NS |
| F X B | NS | NS | NS |
| S X F X B | NS | NS | NS |
| C.V. % | 6.05 | 7.01 | 5.21 |

**Table 5: Available N, $P_2O_5$ and $K_2O$ status (kg/ha) of soil after harvest as influenced by various treatments in *rabi* dhaincha**

| Treatment | Available Nutrient Status (kg/ha) | | |
|---|---|---|---|
| | N (kg/ha) | $P_2O_5$ (kg/ha) | $K_2O$ (kg/ha) |
| **Spacing (S)** | | | |
| $S_1$ = 45cm | 234.88 | 33.02 | 321.02 |
| $S_2$ = 60cm | 235.50 | 34.07 | 323.42 |
| S. Em. ± | 4.31 | 1.39 | 3.70 |
| C.D. (P=0.05) | NS | NS | NS |
| C.V. % | 7.49 | 16.87 | 4.75 |
| **Inorganic Fertilizer (F)** | | | |
| $F_1$ = 75 % RDF | 243.26 | 33.75 | 326.37 |
| $F_2$ = 100 % RDF | 244.45 | 36.34 | 334.07 |
| S. Em. ± | 3.71 | 1.17 | 5.37 |
| C.D. (P=0.05) | NS | NS | NS |
| C.V. % | 6.46 | 14.22 | 6.90 |
| **Biofertilizer (B)** | | | |
| $B_0$ = No Bio fertilizer | 239.76 | 32.24 | 325.07 |
| $B_1$ = *Rhizobium* | 240.51 | 33.12 | 327.07 |
| $B_2$ = PSB | 241.30 | 34.05 | 329.43 |
| $B_3$ = *Rhizobium* + PSB | 245.45 | 38.76 | 331.32 |
| S. Em. ± | 2.68 | 1.15 | 4.79 |
| C.D. (P=0.05) | NS | NS | NS |
| **Interaction** | | | |
| S X F | NS | NS | NS |
| S X B | NS | NS | NS |
| F X B | NS | NS | NS |
| S X F X B | NS | NS | NS |
| C.V. % | 5.72 | 17.10 | 7.54 |
| **Mean** | 240.63 | 34.41 | 327.22 |
| **Initial** | **232.50** | **32.20** | **344** |

*[MS received: March 1, 2013 ]* *[MS accepted: April 28,2013]*