

## Effect of integrated weed management and intercropping systems on growth and yield of pearl millet (*Pennisetum glaucum*)

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Received : December 2002

### ABSTRACT

An experiment was conducted during the rainy season of 1999 and 2000 at S.K.N. College of Agriculture, Jobner (Jaipur), on loamy sand soil, to evaluate the effect of integrated weed management and intercropping systems on growth and yield of pearl millet [*Pennisetum glaucum* (L.) Br. emend. Stuntz]. Intercropping systems significantly reduced weed population and dry-matter production compared to sole pearl millet. Lowest weed population (117/m<sup>2</sup>) and dry weight (975 kg/ha) were recorded under pearl millet + cowpea [*Vigna unguiculata* (L.) Walp.] followed by pearl millet + greengram (*Phaseolus radiatus* L.), while maximum under sole pearl millet at harvest. The sole pearl millet recorded significantly higher tillers/plant and crop dry matter at harvest than all the 3 intercropping systems, whereas plant height under sole pearl millet being at par with pearl millet + clusterbean [*Cyamopsis tetragonoloba* (L.) Taubert]. Sole pearl millet gave significantly more ear length, grains/ear, grain (20.8 q/ha), stover (54.9 q/ha) and biological (75.6 q/ha) yields compared to rest of the intercropping systems, while highest pearl millet-grain-equivalent yield was recorded under pearl millet + clusterbean (39.1 q/ha), followed by pearl millet + greengram over pearl millet + cowpea and sole pearl millet. Hand-weeding twice at 30 and 45 days after sowing remained at par with pendimethalin and oxadiazon each at 1.0 kg/ha supplemented with hand-weeding once at 45 days after sowing recorded the lowest weed population (77/m<sup>2</sup>) and dry-matter production (625 kg/ha) compared to rest of the weed-management practices. The crop dry matter, plant height, tillers/plant, ears/plant, ear length and grains/ear increased significantly under all the weed-control measures compared to unweeded control with maximum values under hand-weeding twice. Similarly, all weed-control measures gave significantly higher grain, stover, biological and grain-equivalent yields of pearl millet compared to weedy check but maximum values were obtained under hand-weeding twice (22.9 q/ha grain, 61.5 q/ha stover, 84.4 q/ha biological and 41.4 q/ha grain-equivalent yields), followed by pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once at 45 days after sowing.

**Key words :** Integrated weed management, Intercropping system, Pearl millet, Clusterbean, Cowpea, Greengram, Pendimethalin, Oxadiazon, Growth, Yield

Weed infestation is one of the major constraints for low yield of pearl millet. Weeds compete with the crop plants for the essentials of growth, interfere with the utilization of land and water resources, and thus, adversely affects crop production. Weeds deplete 30-40% of applied nutrients from soil and compete with the crop plants for soil moisture and sunlight too (Mani, 1977). The losses caused by weeds exceed the losses from any other category of agricultural pests. In India, weeds are responsible for about 33% of total crop loss amounting Rs 1980 crore per annum (Kulshrestha and Parmar, 1992).

Keeping a crop weed free throughout the crop season is a labour and cost-intensive affair. In order to get desired degree of weed control, the operation has to be repeated but manual operation at several times becomes difficult

due to frequent intermittent rains. Moreover, hand-weeding is laborious, cumbersome and time-consuming besides being and economically not feasible in today's intensive agriculture. Chemical weed control is reported to be more effective and economical than mechanical weed control.

The arable land is a precious and scarce resource so, among the options to increase production, the cropping intensity and efficient utilization of available resources seems more feasible over increasing area under cultivation. But, under rainfed conditions only one growing season is available for cropping, so the farmers simultaneously have to raise two or more crops on the same piece of land to derive maximum output per unit of land, through intercropping system. Sowing of pearl millet in

paired row (30/60 cm) system has been proved advantageous over uniform row system, as it widens the scope of introducing a legume as an intercrop without having any adverse effect on the productivity of the base crop (Gautam, 1989). Present investigation was therefore carried out to increase the production of pearl millet through integrated weed management and intercropping systems.

## MATERIALS AND METHODS

The field experiment was conducted during the rainy season of 1999 and 2000 at Agronomy Farm, SKN College of Agriculture, Jobner (Rajasthan). The soil was loamy sand having bulk density  $1.50 \text{ Mg/m}^3$  with pH 8.2. The soil was poor in organic carbon (0.20%), low in available nitrogen ( $128.00 \text{ kg/ha}$ ), medium in phosphorus ( $16.80 \text{ kg/ha}$ ) and potash ( $157.50 \text{ kg/ha}$ ). The experiment consisted of 28 treatment combinations of four intercropping systems (sole pearl millet, pearl millet + cowpea, pearl millet + clusterbean and pearl millet + greengram) in main plots and 7 weed-control measures (unweeded control, pendimethalin at  $1.0 \text{ kg/ha}$ , pendimethalin at  $1.0 \text{ kg/ha}$  + hand-weeding once at 45 DAS, oxadiazon at  $1.0 \text{ kg/ha}$ , oxadiazon at  $1.0 \text{ kg/ha}$  + hand-weeding once at 45 DAS, hand-weeding once at 30 DAS and hand-weeding twice at 30 and 45 DAS) in subplots was laid out in split-plot design replicated 4 times. Pearl millet variety 'MH 179', cowpea 'RC 19', clusterbean 'RGC 197' and greengram 'RMG 62' were sown on 12 and 17 July in 1999 and 2000 respectively. The seeds were sown in rows 45 cm apart for sole pearl millet. In intercrop situation, pearl millet was sown in paired rows at 30 cm keeping 60 cm distance between 2 pairs to adjust 1 row of intercrop (30/60 cm). The plant to plant distance of 15 cm in pearl millet and 10 cm in intercrops was maintained. The recommended seed rates of 4 and  $16 \text{ kg/ha}$  for pearl millet and intercrops, respectively, were used in the experiment. Herbicides were applied as preemergence and hand-weeding was done as per treatments. The recommended dose of  $60 \text{ kg N/ha}$  through urea and  $30 \text{ kg P}_2\text{O}_5/\text{ha}$  through single superphosphate was applied to sole as well as intercrops. Half dose of N and full dose of P were drilled before sowing and remaining N was top-dressed at 30 days.

## RESULTS AND DISCUSSION

### Population and dry-matter of weeds

Intercropping systems significantly reduced the population and dry matter of weeds at harvest compared to sole pearl millet, but statistically remained at par with pearl millet + cowpea and pearl millet + greengram (Table 1). The lowest weed population and dry weight were observed under pearl millet + cowpea followed by pearl millet + greengram, while maximum population and dry matter

were recorded in sole pearl millet. The lowest population and dry matter production of weeds under intercropping systems may be ascribed probably due to higher crop canopy than sole pearl millet. Extensive canopy of intercrops precluded penetration of solar radiation up to the weeds and smothered them leading to lower weed dry weight. Results corroborate with the findings of Tewari *et al.* (1989).

All the weed-management practices significantly reduced the weed population and dry matter compared to unweeded control (Table 1). Hand-weeding twice at 30 and 45 DAS being at par with pendimethalin and oxadiazon each at  $1.0 \text{ kg/ha}$  + hand-weeding once at 45 DAS recorded significantly lower weed population and dry matter at harvest compared to rest of the weed-management practices. Highest weed dry matter was recorded at harvest under unweeded control, while hand-weeding twice at 30 and 45 DAS reduced the weed dry matter compared with unweeded control. The increase in population and dry matter of weeds to such a high level under unweeded control may be attributed to uninterrupted weed growth throughout the crop season. Herbicides absorbed by germinating weeds inhibits cell-division in the meristematic tissues resulting in death of most of the weeds within a few days of their emergence, disruption of microtubule and inhibits synthesis of seedlings followed by chlorosis and inhibition of elongation of leaves therefore, most of the weeds died within a few days of their emergence. These herbicides gave almost season-long control of weeds obviously due to their persistence in soil for a sufficiently long time. The results are in conformity with those reported by Verma and Katyal (1989) in pearl millet.

### Growth parameters

Intercropping systems significantly influenced the plant height, tillers/plant and dry matter of pearl millet at harvest (Table 1.) The tallest plants of pearl millet under sole pearl millet being at par with pearl millet + clusterbean, was significantly higher than pearl millet intercropped with cowpea and greengram. Further, pearl millet intercropped with clusterbean, being at par with pearl millet + greengram, attained significantly higher plant height over its association with cowpea. The respective increase in plant height at harvest under sole pearl millet was 10.07 and 6.98 % over pearl millet + cowpea and pearl millet + greengram respectively. Similarly, sole pearl millet gave significantly higher tillers/plant and dry-matter yield over pearl millet intercropped with cowpea, clusterbean and greengram. However, pearl millet intercropped with legumes did not differ significantly with each other in respect to tillers/plant at harvest. Among different intercropping systems, pearl millet + clusterbean recorded the maxi-

mum plant height, tillers/plant and dry matter.

Better growth and dry matter in sole pearl millet might be the result of maximum utilization of nutrients and resources on account of competition-free atmosphere available under sole cropping with added advantage of optimum spacing. Significant increase in crop dry matter with sole pearl millet may again be attributed to the similar increase in plant height and tillers/plant under this treatment. Significantly higher dry matter of pearl millet recorded under pearl millet + clusterbean compared to pearl millet intercropped with cowpea and greengram may be ascribed to similar increase in plant height with concomitant slight increase in tillers/plant under this treatment probably as a result of reduced competition due to lesser crop canopy of erect/unbranched type of clusterbean variety used than that of cowpea and greengram intercrops. Our results confirm the findings of Ikramulah *et al.* (1996).

Weed control measures significantly increased plant height, tillers/plant and dry matter production of the crop compared with the unweeded control at harvest (Table 1). Hand-weeding twice, pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once being at par with each other, significantly increased the plant height, tillers/plant and dry matter over rest of the weed control treatments at harvest. Hand-weeding once, pendimethalin and oxadiazon each at 1.0 kg/ha were at par for growth parameters at 60 DAS and harvest. The weed-control treatments were found very effective to improve the crop growth in terms of plant height, tillers/plant and dry matter. A linear

relationship in weed-control efficiency and crop growth was noticed under all the weed-management practices.

The better growth and development of the plants under different weed-control treatments was the resultant of weed-free environment with lesser competition for the essentials of crop growth. Whereas, uncontrolled growth of weeds throughout the crop season in unweeded control plots caused severe crop-weed competition resulting in significantly lower growth parameters compared to other weed control treatments. Verma and Katyal (1989) and Kumar and Mohammed (1993) also recorded similar findings in pearl millet.

#### **Yield attributes and yield**

Sole pearl millet had significantly higher ear length and grains/ear than pearl millet intercropped with cowpea, clusterbean and greengram and the respective increase was of 8.13 and 7.44 %, 5.42 and 9.82% and 5.81 and 5.56% (Table 2). However, all the intercropping systems remained statistically at par with each other. Further, sole pearl millet significantly increased the grain, stover and biological yields of pearl millet by 13.86, 8.53 and 9.99%, 10.83, 5.72 and 7.12% and 12.13, 6.19 and 7.82%, respectively, over pearl millet + cowpea, pearl millet + clusterbean and pearl millet + greengram intercropping systems. However, intercropping systems significantly influenced the pearl millet-grain-equivalent yield compared to sole pearl millet. Maximum pearl millet-grain-equivalent yield was obtained under pearl millet + clusterbean being at par

**Table 1.** Effect of intercropping systems and weed management on density and dry matter of weeds and growth parameters of pearl millet (pooled data of 2 years)

| Treatment                                        | Weed density/m <sup>2</sup> | Weed dry matter (kg/ha) | Plant height (cm) | Tillers/plant | Dry matter of pearl millet (kg/ha) |
|--------------------------------------------------|-----------------------------|-------------------------|-------------------|---------------|------------------------------------|
| <i>Intercropping system</i>                      |                             |                         |                   |               |                                    |
| Sole pearl millet                                | 162                         | 1,333                   | 164.8             | 3.04          | 7,099                              |
| Pearl millet + cowpea                            | 117                         | 975                     | 148.2             | 2.61          | 6,310                              |
| Pearl millet + clusterbean                       | 129                         | 1,023                   | 158.4             | 2.68          | 6,642                              |
| Pearl millet + greengram                         | 119                         | 988                     | 153.3             | 2.62          | 6,513                              |
| CD (P=0.05)                                      | 8.7                         | 56.2                    | 5.6               | 0.11          | 270.1                              |
| <i>Weed control</i>                              |                             |                         |                   |               |                                    |
| Unweeded control                                 | 363                         | 2,982                   | 122.4             | 2.02          | 3,529                              |
| Pendimethalin 1.0 kg/ha (PE)                     | 111                         | 894                     | 151.7             | 2.70          | 6,694                              |
| Pendimethalin 1.0 kg/ha (PE) + HW once at 45 DAS | 76                          | 641                     | 173.0             | 3.03          | 7,638                              |
| Oxadiazon 1.0 kg/ha (PE)                         | 114                         | 913                     | 149.6             | 2.64          | 6,694                              |
| Oxadiazon 1.0 kg/ha (PE) + HW once at 45 DAS     | 79                          | 649                     | 168.1             | 3.00          | 7,555                              |
| Hand-weeding once at 30 DAS                      | 103                         | 858                     | 154.6             | 2.70          | 6,755                              |
| Hand-weeding at 30 and 45 DAS                    | 77                          | 625                     | 174.0             | 3.08          | 7,696                              |
| CD (P=0.05)                                      | 8.2                         | 62.2                    | 6.5               | 0.12          | 289.1                              |

PE, Pre-emergence; HW, hand-weeding; DAS, days after sowing

with pearl millet + greengram significantly higher over sole pearl millet and pearl millet + cowpea by 46.9 and 10.4% respectively. Pearl millet intercropped with cowpea, greengram and clusterbean being at par caused significant reduction in weed-competition index compared to sole pearl millet. Higher pearl millet grain yield in sole pearl millet compared to intercropping system is attributed to more ears/plant, ear length and grains/ear (Table 2). The reduction in grain yield of pearl millet under intercropping of cowpea, clusterbean and greengram seems to be associated with competitive effects due to vigorous and luxuriant vegetative growth of these intercrops. However, higher stover yield of pearl millet was obtained in pure stand evidently owing to increase in growth parameters, viz. plant height and tillers/plant. The results are in agreement with those of Ikramullah *et al.* (1996).

All the weed-control measures significantly increased the ears/plant, length of ear and grains/ear over unweeded control, being maximum under hand weeding twice. These were at par with pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once and were significantly higher over hand weeding once, pendimethalin at 1.0 kg/ha and oxadiazon at 1.0 kg/ha. However, hand-weeding once remained at par with pendimethalin and oxadiazon each at 1.0 kg/ha. Hand-weeding twice being at par with pendimethalin 1.0 kg/ha + hand weeding once, resulted in

the maximum grain, stover, biological and grain equivalent yields of pearl millet which were significantly higher over rest of the weed-control measures. The next best treatments were pendimethalin and oxadiazon each at 1.0 kg/ha supplemented with 1 hand-weeding at 45 DAS being at par recorded significantly higher equivalent yield than hand weeding once and herbicides alone. It registered an increase of 56.37, 19.02, 20.98, 18.54 and 5.93% in grain yield over unweeded control, pendimethalin at 1.0 kg/ha, oxadiazon at 1.0 kg/ha, hand-weeding once and oxadiazon at 1.0 kg/ha + hand-weeding once respectively. Among the herbicidal treatments, pre-emergence application of pendimethalin at 1.0 kg/ha supplemented with hand-weeding once recorded the maximum mean grain yield of 22.18 q/ha which was a significant increase of 54.19% over the unweeded control. Hand-weeding once, pendimethalin and oxadiazon each at 1.0 kg/ha being at par with each other, though proved least effective among the weed-control measures in giving the grain yield but were significantly superior to unweeded control.

As none of the treatments was found free of weeds, the highest yield producing treatment, i.e. hand-weeding twice was treated as weed-free plot to worked out the weed-competition index in the present study. Weed-control measures significantly reduced the weed competition index compared to unweeded control. The season-long weed-

**Table 2.** Effect of intercropping systems and weed management on yield attributes, yield and weed competition index of pearl millet (pooled data of 2 years)

| Treatment                                           | Ears/<br>plant | Ear<br>length<br>(cm) | Grains/<br>ear | Test<br>weight<br>(g) | Yield<br>(q/ha) |        |            | Pearlmillet-<br>grain-<br>equivalent<br>yield<br>(q/ha) | Weed-<br>competi-<br>tion<br>index<br>(%) |
|-----------------------------------------------------|----------------|-----------------------|----------------|-----------------------|-----------------|--------|------------|---------------------------------------------------------|-------------------------------------------|
|                                                     |                |                       |                |                       | Grain           | Stover | Biological |                                                         |                                           |
| <i>Intercropping system</i>                         |                |                       |                |                       |                 |        |            |                                                         |                                           |
| Sole pearl millet                                   | 2.09           | 25.8                  | 1223           | 6.02                  | 20.77           | 54.86  | 75.63      | 20.77                                                   | 21.70                                     |
| Pearlmillet + cowpea                                | 1.99           | 23.7                  | 1132           | 6.08                  | 17.89           | 50.18  | 68.07      | 35.07                                                   | 15.79                                     |
| Pearlmillet + clusterbean                           | 2.02           | 24.4                  | 1164           | 6.12                  | 18.52           | 51.72  | 70.24      | 39.15                                                   | 16.42                                     |
| Pearlmillet + greengram                             | 2.00           | 24.3                  | 1155           | 6.18                  | 18.25           | 51.46  | 69.71      | 38.89                                                   | 16.08                                     |
| CD (P=0.05)                                         | NS             | 0.80                  | 35.85          | NS                    | 0.99            | 1.89   | 2.66       | 1.48                                                    | 0.73                                      |
| <i>Weed control</i>                                 |                |                       |                |                       |                 |        |            |                                                         |                                           |
| Unweeded control                                    | 1.07           | 19.7                  | 1054           | 5.92                  | 10.00           | 29.60  | 39.60      | 15.52                                                   | 55.90                                     |
| Pendimethalin 1.0 kg/ha (PE)                        | 1.99           | 24.2                  | 1179           | 6.06                  | 18.56           | 51.29  | 69.85      | 32.97                                                   | 18.75                                     |
| Pendimethalin 1.0 kg/ha (PE) + HW<br>once at 45 DAS | 2.38           | 26.2                  | 1204           | 6.19                  | 22.18           | 60.19  | 82.37      | 39.94                                                   | 3.08                                      |
| Oxadiazon 1.0 kg/ha (PE)                            | 1.94           | 24.1                  | 1162           | 6.03                  | 18.11           | 51.00  | 69.11      | 32.32                                                   | 20.74                                     |
| Oxadiazon 1.0 kg/ha (PE) + HW<br>once at 45 DAS     | 2.35           | 26.1                  | 1184           | 6.15                  | 21.56           | 59.69  | 81.25      | 38.81                                                   | 5.66                                      |
| Hand-weeding once at 30 DAS                         | 2.02           | 24.8                  | 1177           | 6.11                  | 18.67           | 51.36  | 70.03      | 33.37                                                   | 18.34                                     |
| Hand-weeding twice at 30, 45<br>DAS                 | 2.43           | 26.6                  | 1219           | 6.25                  | 22.92           | 61.48  | 84.40      | 41.42                                                   |                                           |
| CD (P=0.05)                                         | 0.08           | 0.98                  | 38.24          | NS                    | 1.03            | 2.07   | 2.73       | 1.31                                                    | 0.80                                      |

PE, Pre-emergence; HW, hand-weeding; DAS, days after sowing

infestation reduced the pearl millet seed yield by 55.9% compared to hand-weeding twice. Among the weed-control measures, pendimethalin at 1.0 kg/ha + hand-weeding once recorded the minimum weed competition index (3.08%), followed by oxadiazon at 1.0 kg/ha + hand-weeding once (5.66%) which were significantly lower than recorded under rest of the weed-control treatments. The variation in grain and stover yield due to different weed-control treatments is associated with the similar variation in weed dry matter production. The lowest grain and stover yields recorded in unweeded control plots may be ascribed to the maximum competition of weeds with the crop plants for growth essentials leading to maximum weed competition index (55.90%). On the other hand, the higher grain yield obtained owing to hand-weeding twice, pendimethalin and oxadiazon each at 1.0 kg/ha accompanied by hand-weeding once was associated with the least competition of weeds under these treatments. Further, hand-weeding twice was done manually with the help of hand hoe, which makes the soil porous and creates favorable environment for root growth in addition to effective control of weeds. Kaushik and Gautam (1984) also reported improvement in yields components due to elimination of severe crop-weed competition. Higher seed yield, thus, obtained under hand-weeding twice was obviously due to cumulative effect of reduced weed competition and higher value of yield attributes. The results obtained are in

close conformity with the findings of Verma and Katyal (1989) and Kumar and Mohammed (1993).

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