the above results it is clear that the strainer opening ratio plays an important role in the determination of head loss characteristics in foot valves. This is because, the increased strainer opening ratio (S/A) will mean higher strainer opening area (s) for a given strainer surface area (A) and this will facilitate smooth entry of water from sump to the foot valves strainer. The smooth and free entry of water is subjected to loss friction and this leads to lesser coefficient (K). Also the curvilinear path of water particles is altered to straight line path by the larger strainer opening ratio. The straight line path of water particles movement will reduce the frictional resistance. This is in accordance with the elementary rationale that increased opening of the passage should diminish the resistance offered to the flow.

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# INFLUENCE OF RHIZOBIAL INOCULATION AND MICRONUTRIENTS APPLICATION ON THE PRODUCTION OF NITROGEN TRANSPORTING COMPOUNDS IN GREENGRAM (*Vigna radiata* L.WILCZEK)

J.PRABAKARAN[1] and M.RANGARAJAN[2]

ABSTRACT

Seed inoculation with rhizobial strains have significantly enhanced the production and accumulation of nitrogen transporting compounds (Ureides)over untreated control in CO 5 greengram. Among the plant parts, maximum ureide production was observed at nodules and was effectively translocated to flowers and pods through root, stem and leaves. Among the strains inoculated better effect was recorded by GG 2 followed by the other two strains. Maximum translocation and accumulation of ureides were recorded in leaves, stem, root and flowers at 45 DAS, whereas in pods it was found to accumulate at 60 DAS. Incorporation of Fe at 0.5 mM and Mo at 0.5 μM enhanced ureide production in the different parts of greengram.

KEY WORDS: Ureides, Allantoin, Rhizobial inoculation, Micronutrients.

1.Associate Professor, NPRC, Vamban, Pudukkottai-622 303.
2.Professor and Head. Dept. of Microbiology,TNAU.Coimbatore-641 003.

Ureides producing tropical legumes, in contrast to the amide producing temperate legumes, accumulate and translocate allantoin and allantoic acid in different parts of the plant systems due to nitrogen fixation by rhizobia (Atkins, 1982). Distribution and change in the content of allantoin and allantoic acid in nodulating and non-nodulating soybean plants was first published by Matsumoto et al., (1977) and later it was demonstrated that nodules were the sites of allantoin formation (Fugihara and Yamaguchi, 1978). McClure **et al.** (1980) evaluated the relative ureides contents of xylem sap of soybean as an indicator of nitrogen fixation in soybean. Pate **et al.** (1980) by employing $^{15}N$ technique concluded that higher proportion of ureide nitrogen was formed in cowpea plants when they were dependent on the fixed nitrogen by symbiotic rhizobia when they were fed with nitrate. They also reported that in cowpea (**Vigna unguiculata**) and mungbean (**Vigna radiata**), percentages of xylem nitrogen as ureides remained constant during growth. Out of different concentrations of micronutrients it was observed that 0.5 mM iron and 0.5 mM molybdenum influenced the production of allantoin in mungbean (Prabakaran and Rangarajan, 1982). However, no information is available regarding the effect of inoculation with different rhizobial strains on the synthesis and export of fixed nitrogen to the various parts of **Vigna radiata**. Therefore this report deals with the accumulation and transport of allantoin and allantoic acid in the various parts of **Vigna radiata** at different growth periods as influenced by the inoculation of three fast growing rhizobial strains and the effect of iron and molybdenum at 0.5 mM on the accumulation and export of allantoin.

## MATERIALS AND METHODS

Seeds of greengram (**Vigna radiata** L.Wilczek) were inoculated with peat based rhizobial inoculants having fast growing cowpea **Rhizobium** sp. specific for greengram viz., GG 1, GG 2 and GG 3. An inoculum load of $10^7$ cells/g of peat carrier was given. Treated seeds with untreated controls were sown in the pots containing acid washed sterilized sand. Iron and molybdenum were supplied through N-free Jensen's nutrients solution containing 0.5 mM concentration of iron (139 mg Ferrous sulphate/1) and 0.5 mM concentration of Molybdenum (3 mg sodium molybdate/1) after one week of sowing. Each

Table 1. Effect of rhizobial inoculation on the production and accumulation of N Transporting compounds (Ureides) in different parts of greengram at various growth periods

| RHIZOBIAL STRAINS | Allantoin and allantoic acid (µg/g of fresh sample) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Root | | | Stem | | | Leaves | | | Nodules | | Flowers | | Pods | |
| DAS | 30 | 45 | 60 | 30 | 45 | 60 | 30 | 45 | 60 | 30 | 45 | 30 | 45 | 30 | 45 |
| GG 1 | 410 | 612 | 67 | 210 | 810 | 117 | 160 | 392 | 189 | 530 | 1124 | 509 | 1029 | 205 | 291 |
| GG 2 | 426 | 628 | 88 | 227 | 844 | 125 | 178 | 401 | 196 | 567 | 1184 | 539 | 1120 | 248 | 306 |
| GG 3 | 401 | 618 | 67 | 211 | 809 | 119 | 159 | 386 | 181 | 484 | 1117 | 460 | 1068 | 217 | 286 |
| Control | 210 | 501 | 31 | 120 | 620 | 90 | 130 | 271 | 156 | 348 | 990 | 255 | 911 | 185 | 201 |
| SED | 1.1 | 5.2 | 1.9 | 1.7 | 1.9 | 9.9 | 1.6 | 3.7 | 3.4 | 5.0 | 5.0 | 1.7 | 12.8 | 14.3 | 5.8 |
| CD (P = 0.05) | 2.4 | 11.5 | 4.2 | 3.8 | 4.2 | 20.5 | 3.5 | 7.9 | 8.1 | 7.4 | 11.0 | 3.9 | 27.9 | 31.3 | 11.5 |

DAS: Days after sowing.

treatment was replicated five times.

During the plant growth, different plant parts viz., nodules, root, stem, leaves, flowers and pods were assayed for allantoin and allantoic acid contents from 30th day onwards at fortnight by intervals till 60 days. One gram each of fresh plant parts was ground with 10 ml of 0.05M phosphate buffer (pH 7.0) for 10 min. The clear supernatant was used for assaying the ureides (allantoin and allantoic acid) as per the method described by Young and Convey (1942).

The allantoin and allantoic acid were measured by hydrolysing into urea and glyoxalic acid by adding 0.5 N NaOH. Glyoxalic acid was estimated by adding phenyl hydrazine hydrochloride and the activity of ureides were measured at 520 nm in UV-2000 Double Beam Spectrophotometer (Shimadzu, Japan) and the ureides content expressed as µg of allantoin per g of fresh weight of plant sample by using pure allantoin as a standard source.

## RESULTS AND DISCUSSIONS

Inoculation with rhizobial strains significantly enhanced the production, translocation and accumulation of ureides in various growth stages in different parts of greengram over uninoculated control (Table 1). Among the different plant parts, maximum ureide production was recorded in the nodule region and effectively accumulated to flowers and pods at the maturity stage. Among the strains of rhizobia, irrespective of plant parts and growth stages, maximum ureides production was effected by the inoculation of GG 2 followed by other strains which varied in their performances in the plant parts and different stages. Irrespective of the strains inoculated and plant parts, the maximum production, translocation and accumulation of ureides were recorded at 45 DAS except in pods in which the peak level was recorded at 60 DAS.

The result on the influence of iron at 0.5mM have indicated that iron incorporation had significantly influenced the accumulation of allantoin and allantoic acid in the different parts of mungbean plant. (Table 2). As the previous experiment had clearly indicated that the effect of rhizobial inoculation was evident after the formation of nodules, the observations

Table 2. Effect of iron at 0.5 mM on the N transporting compounds in greengram (CO 5) with three rhizobial strains

| Growth Stage / Rhizobial strains | Roots | | Nodules | | Stems | | Leaves | | Flowers | | Pods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | C | T | C | T | C | T | C | T | C | T | C |
| **30th day :** | | | | | | | | | | | | |
| GG 1 | 234 | 194 | 368 | 291 | 184 | 121 | 117 | 86 | 325 | 206 | — | — |
| GG 2 | 306 | 223 | 494 | 331 | 270 | 141 | 197 | 89 | 439 | 356 | — | — |
| GG 3 | 244 | 206 | 348 | 301 | 171 | 106 | 149 | 81 | 376 | 323 | — | — |
| **45th day :** | | | | | | | | | | | | |
| GG 1 | 161 | 126 | 483 | 315 | 193 | 151 | 176 | 141 | 478 | 326 | 265 | 180 |
| GG 2 | 204 | 139 | 516 | 351 | 246 | 173 | 236 | 196 | 526 | 365 | 279 | 220 |
| GG 3 | 155 | 117 | 416 | 310 | 179 | 140 | 171 | 136 | 393 | 310 | 241 | 201 |
| **60th day:** | | | | | | | | | | | | |
| GG 1 | 89 | 53 | — | — | 158 | 128 | 223 | 180 | — | — | 345 | 280 |
| GG 2 | 121 | 83 | — | — | 198 | 160 | 296 | 116 | — | — | 383 | 289 |
| GG 3 | 93 | 50 | — | — | 148 | 118 | 213 | 186 | — | — | 325 | 250 |
| CD | | | | | | | | | | | | |
| Nutrient | 12.2 | | 48.8 | | 23.1 | | 30.2 | | 58.1 | | 36.3 | |
| Days | 28.1 | | 9.5 | | 6.5 | | 18.7 | | 11.0 | | 48.6 | |
| Strains | 47.3 | | 18.9 | | 11.9 | | 5.4 | | 15.0 | | 16.0 | |
| Interaction | — | | 6.8 | | — | | — | | 7.8 | | 5.2 | |

* ( μg of allantoin produced/g of sample)

T - Treated Fe at 0.5 mM.

C - Untreated Control - No Fe.

Table 3. Effect of molybdenum at 0.5 mM on the N transporting compounds in greengram with three rhizobial strains

| Growth Stage / Rhizobial strains | Roots | | Nodules | | Stems | | Leaves | | Flowers | | Pods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | C | T | C | T | C | T | C | T | C | T | C |
| **30th day :** | | | | | | | | | | | | |
| GG 1 | 276 | 189 | 418 | 355 | 234 | 149 | 106 | 65 | 428 | 358 | — | — |
| GG 2 | 287 | 213 | 480 | 389 | 247 | 151 | 147 | 99 | 471 | 411 | — | — |
| GG 3 | 256 | 181 | 468 | 404 | 120 | 106 | 139 | 85 | 461 | 413 | — | — |
| **45th day :** | | | | | | | | | | | | |
| GG 1 | 315 | 215 | 638 | 546 | 336 | 285 | 292 | 210 | 871 | 791 | 210 | 180 |
| GG 2 | 328 | 241 | 719 | 635 | 346 | 291 | 302 | 220 | 971 | 865 | 280 | 218 |
| GG 3 | 288 | 210 | 630 | 517 | 264 | 217 | 226 | 210 | 845 | 715 | 178 | 120 |
| **60th day :** | | | | | | | | | | | | |
| GG 1 | 155 | 81 | — | — | 151 | 121 | 215 | 196 | — | — | 315 | 201 |
| GG 2 | 128 | 96 | — | — | 183 | 129 | 262 | 211 | — | — | 361 | 312 |
| GG 3 | 110 | 79 | — | — | 148 | 128 | 206 | 180 | — | — | 296 | 280 |

| CD : | Roots | Nodules | Stems | Leaves | Flowers | Pods |
|---|---|---|---|---|---|---|
| Nutrient | 18.6 | 54.0 | 20.1 | 14.1 | 38.6 | 15.4 |
| Days | 66.0 | 84.5 | 96.0 | 58.1 | 101.8 | 18.1 |
| Strains | 4.8 | 8.0 | 5.0 | 4.1 | 2.4 | 15.0 |
| Interaction | -- | 4.9 | 2.9 | 2.2 | — | 6.2 |

* ( µg of allantoin produced/g of sample)

T - Treated Mo at 0.5 mM

C - Control - No Mo.

were recorded after 30 DAS. Since rhizobial inoculation had definitely influenced the increase in allantoin production, inoculated plants with and without the application of the micronutrients were included in the later experiments.

Nodules and flowers accumulated higher concentrations of allantoin at 30 DAS in iron applied plants than the control plants (Table 2). A similar trend was seen at 45 DAS during which nodules and flowers were found to contain allantoin at higher concentration than the other parts of the plants. At 60 DAS, pods accumulated the maximum level of allantoin. The plants inoculated with rhizobial strains GG 2 accumulated allantoin at higher level than other strains.

Molybdenum at 0.5 mM favoured the accumulation of higher concentration allantoin in nodules and flowers at 30 DAS (Table 3). Accumulation of allantoin increased in all parts of the plant except in pods as the plant matured. The concentration of allantoin decreased gradually at 60 DAS during which pods accumulated the maximum quantity. Althouth GG 2 strain influenced the accumulation of allantoin, the molybdenum treated plants exhibited higher concentration of the compound than the control plants.

As azoferredoxin and molybdoferredoxin are the compounds of nitrogenase, the effect of iron and molybdenum on the preduction of ammonia assimilatory enzymes was evident (Prabakaran and Rangarajan, 1982). This clearly indicated that not only rhizobial strains enhance the allantoin production but also iron and molybdenum at 0.5 mM concentration increased the accumulation and transporting of this nitrogen transporting compounds in greengram.

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# PERFORMANCE OF WHEAT VARIETY UNDER LIMITED MOISTURE SUPPLY CONDITIONS IN HEAVY SOILS

M.S.SHAKTAWAT and N.L.JOSHI
Division of Agronomy, Sukhadia University,
Agricultural Experiment Station,
Durgapura: Jaipur (Raj.) India.

ABSTRACT

Performance of wheat varieties under limited moisture supply conditions on heavy soils showed that two irrigations increased grain production over no post-sowing irrigation and one irrigation by 46 and 23 per cent respectively. Straw yield increased due to two irrigations at CRI and flag leaf stage by 56 and 14 per cent over no post-sowing irrigation and irrigation at CRI stage respectively. The variety HI-601 gave maximum grain yield followed by J-40, Kalyan Sona and Sonalika.

**KEY WORDS: Wheat, Irrigation, Varieties.**

The role of irrigation assumes a great significance in wheat productions which incidently is a limiting factor in