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Research Article

# Bio-formulations and indigenous technology methods in the management of Asian soybean rust

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ABSTRACT

The present study comprised of thirteen different treatments taken up at MARS, UAS, Dharwad during *Kharif* 2008 to 2010. The treatments were applied thrice with first one immediately after appearance of rust symptoms in the field and subsequently at 10 days interval except chemical check. The pooled analysis over three years revealed that among the ITK measures application of cow urine@10 per cent+*Adthoda vessica@0.5* per cent recorded minimum per cent disease index (PDI) of 39.1.The maximum seed yield of 10.77 q/ha was recorded in seed treatment with cow urine 10 per cent+*Prosopis juliflora*@5 per cent followed by10.60q/ha in cow urine@10 per cent+ neem oil@0.5 per cent. The positive check recorded minimum disease pressure (28.4 PDI) and maximum seed yield of 12.08q/ha.However,the highest disease pressure was in untreated check (84.5 PDI) with seed yield of 8.19q/ha. There was no significant difference with respect to reducing and non-reducing sugars in different treatments. The economics of the disease revealed maximum net income of Rs.15,925 with B:C ratio of 1.45 in cow urine 10 per cent+ *Prosopis juliflora* @0.5 per centfollowed by Rs.15,475 in cow urine 10 per cent +neem oil@0.5 per cent with B:C ratio of 1.41.The minimum net income (Rs.11,475) and B:C ratio of 1.1.12 was recorded in control.

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## INTRODUCTION

The Asian soybean rust is the economically important disease not only in the Sub-continent but also rest of the soybean growing regions of the world. The predominantly associated pathogen, *Phakopsora pachyrhizi*, has been known to drastically reduce yields in Asia. In the areas where the pathogen occurs in the most virulent form, yield losses up to 80 per cent have been reported. Basically the pathogen was confined to eastern hemisphere before it had appeared in epiphytotic form in Hawaii region in 1994. At present, the pathogen has been reported from different continents such as Africa, Asia, Australia, South America and Hawaii. The rapid spread of *P. pachyrhizi* Syd. and potential for severe yield losses makes this, the most destructive foliar disease of soybean. Soybean rust could have a major impact on both total soybean production and production costs in the India. In India, the disease was first reported on soybean in 1951 (Sharma and Mehta, 1996).Two *Phakopsora* species are known to cause soybean rust (Ono *et al.*, 1992).The more aggressive species is *P. pachyrhizi,* known as the Asian soybean rust. *Phakopsora meibomiae*, the less virulent species, has only been found in limited areas in the Western hemisphere, and it is not known to cause severe yield losses in soybean.

Most of the research on control has been focused on the use of fungicides and host plant resistance. Some cultural practices have been recommended that minimize the impact of rust (Desborough,1984). The recommendations differed, but were based upon avoiding the conditions that promote disease development or were practiced to achieve optimized overall yields. Research on biological control has been limited in the management of soybean rust. In recent years the studies on use of Indigenous Technology Knowledge (ITK) measures in the managing the crop diseases have been demonstrated successfully in crops like sorghum, tomato, banana and black pepper (Shamarao Jahagirdar, 1998: Shamarao Jahagirdar *et al*., 2000: Shamarao Jahagirdar *et al*., 2008).The soybean growers of the sub-continent are seriously facing the severe infestation of rust disease in the last few years with a yield loss ranging from 30-100 per cent.There are no resistant cultivars at present for Asian soybean rust and continuous application of fungicides has further aggravated the concern over pesticide resistance. Keeping, these points in view the investigation comprised of screening of Indigenous Technology Knowledge (ITK) measures against Asian soybean rust in India and with an aim of enhancing the productivity in terms of both quality and quantity soybean yields in India.

## MATERIALS AND METHODS

The present study comprised of thirteen different treatments taken up at Main Agricultural Research Station (MARS), University of Agricultural Sciences (UAS), Dharwad during *Kharif* 2008, 2009 and 2010. The treatments were applied thrice with first one immediately after appearance of rust symptoms in the field and subsequently at 10 days interval in case of biorationals and two sprays in case of chemical check at 15 days interval.

The most susceptible cultivar JS 335 was employed in the present study. The trial was replicated three times with a plot size of 2.7x4.0mt.The sowing dates in different years were 22-07-2008 and 6-7-2009 and 25-7-2010. The different treatments were applied on 04-09-2008, 15-09-2008 and 01-10-2008 during 2008 and 18-9-2009, 25-9-2009, 2-10-2009 during 2009, 15-9-2010, 24-9-2010 and 4-10-2010 during 2010.The seasonal conditions revealed late on set of monsoon in the region. The total rainfall received was 926.8 mm spread over 60 rainy days in 2008. In 2009, total rainfall received was 1022.6 mm spread over 66 rainy days and during 2010, total rainfall of 951.9 mm was received with 69 rainy days. The receipt of above normal rainfall during August and September months coupled with high relative humidity and intermittent rainfall resulted in epiphytotics of rust during the experimental years. Hence, all the three seasons were more congenial for soybean rust severity. Observations on rust severity were recorded as per the scale of Mayee and Datar (1986) when the crop was 85 days old. For scoring the intensity of rust, ten plants were randomly selected in the central rows of the plots. The per cent disease index (PDI) was further calculated using the formula of Wheeler (1969) and seed yield was also recorded at harvest (q/ha) and also the treatments were analysed for reducing and non-reducing sugars. The economics was calculated for pooled data over three years which helps in arriving at stable relationship of data instead of individual years. The data were statistically analysed as per procedures of Sukhatme and Amble (1985).

## RESULTS AND DISCUSSION

The research results on effectiveness of biorationals and ITK measures are presented in Table 1 to 3. The results indicated that during 2008, the minimum per cent disease index was recorded in Hexaconazole @1ml/l(17.29) which differed significantly from rest of the treatments. Among the ITK measures application of cow urine@10 per cent+*Pongamia pinnata* oil@0.5 per cent recorded minimum per cent disease index (PDI) of 32.10 followed by cow urine@10 per cent alone (34.57).The treatments cow urine @ 10 per cent + $MnSO_4$ @ 0.3 per cent, cow urine @ 10 per cent + Multik @ 0.5 per cent, cow urine @ 10 per cent + *Adathoda vessica* @ 5 per cent and cow urine @ 10 per cent alone were statistically at par with each other. The maximum seed yield of 9.70q/ha was recorded in Hexaconazole@0.1 per cent. The highest disease pressure was in untreated check (67.89 PDI) with seed yield of 6.78q/ha. During 2009, among the ITK measures minimum disease pressure was recorded in seed treatment with cow urine @ 10 per cent + *Prosopis juliflora* @ 5 per cent @10 per cent(39.6 PDI) followed by spray with neem oil alone @1(40.6PDI).However, there was no significant difference with respect to disease severity among different ITK measures. Maximum seed yield of 11.82q/ha was recorded in seed treatment with cow urine @ 10 per cent + *Prosopis juliflora* @ 5 per cent followed by 11.64q/ha in cow urine@10 per cent alone. The positive check hexaconazole @0.1 per cent recorded disease pressure of 32.2PDI and seed yield of 12.33q/ha. The maximum disease pressure was in control (86.7 PDI) with a seed yield of 8.52 q/ha. During 2010, among the ITK measures,the minimum PDI was recorded in cow urine @1 per cent +*Adathoda vessica @0.5* per cent (39.2PDI) followed by 46.7 PDI in neem oil alone@1 per cent. The positive check hexaconazole@0.1 per cent recorded minimum disease pressure (28.8 PDI) with maximum seed yield (14.22q/ha).However, untreated control recorded maximum disease pressure (94.1 PDI) with seed yield of 9.27q/ha. The pooled analysis over three years revealed All the different. The pooled analysis over two years revealed.

The pooled analysis over three years revealed that among the ITK measures application of cow urine@10 per cent+*Adthoda vessica*@0.5 per cent recorded minimum per cent disease index (PDI) of 39.1 followed by cow urine@10 per cent +*Pongamia pinnata* oil@0.5 per cent(39.1PDI) and cow urine10 per cent+Multi K@0.5 per cent (39.3PDI).The maximum seed yield of 10.77 q/ha was recorded in seed treatment with cow urine 10 per cent+*Prosopis juliflora*@5 per cent followed by10.60q/ha in Cow urine@10 per cent+ neem oil@0.5 per cent. The positive check recorded minimum disease pressure (28.4 PDI) and maximum seed yield of 12.08q/ha.However,the highest disease pressure was in untreated check (84.5 PDI) with seed yield of 8.79q/ha. The study over two years clearly indicated superiority of all the ITK measures in checking soybean rust and there was no significant difference with respect to disease pressure. Cow urine @ 10 per cent + *Prosopis juliflora* @ 5 per cent and cow urine @ 10 per cent + Pottasium phosphonate @ 0.3 per cent differed significantly over other ITK measures with regard to seed yield.

In the present investigation use of chemical elicitors like Multi K and $MnSO_4$, plant based extracts like *Adathoda vesica*,*Prospopis juliflora*,*Pongamia pinnata* oil, Neem oil, Cristol and bioagent *Trichoderma harzianum* in combination with cow urine triggered the host defense resulting in significant reduction in disease pressure when compared to untreated check (Table 1).The application of neem oil alone has not resulted in significant reduction in disease pressure. Thus, the study clearly indicated benefits of combined application of cow urine along with biorationals giving good protection against Asian soybean rust.

The results on analysis of reducing and non reducing sugars are presented in Table 2.The results indicated maximum reducing sugars (0.660) in hexaconazole@0.1 per cent followed by 0.647,0.593 in cae of cow urine 10 per cent+*Prosopis juliflora* @0.5 per cent and cow urine@10 per cent+ neem oil@0.5 per cent, respectively. There was no significant difference with respect to reducing sugars in different treatments. The minimum reducing sugar (0.383) was recorded in untreated control. The non-reducing sugars ranged from 7.01 to 9.45.The maximum non reducing sugar of 9.45 per cent was recorded in cow urine 10 per cent+ $MnSO_4$@0.3 per cent followed by 9.18 and 9.10 in case of neem oil@0.1 per cent and cow urine @ 10 per cent, respectively. However, positive check Hexaconazole recorded 7.38 and untreated check (7.01)non- reducing sugars.

The results on economic analysis of pooled data are

**Table 1: Integrated management of soybean rust through indigenous technology knowledge.**

| Sr. No. | Treatments | PDI | | | | Seed yield (kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2008 | 2009 | 2010 | Mean | 2008 | 2009 | 2010 | Mean |
| 1. | Cow urine @ 10% + $MnSO_4$ @ 0.3% | 38.27 | 44.4 | 46.7 | 39.8 | 643 | 994 | 1159 | 9.32 |
| | | (38.2) | (41.8)* | (43.1) | (40.9) | | | | |
| 2. | Cow urine @ 10% + Multik @ 0.5% | 35.80 | 45.9 | 44.4 | 39.1 | 714 | 997 | 1228 | 10.35 |
| | | (36.7) | (42.6) | (41.8) | (39.7) | | | | |
| 3. | Cow urine @ 10% + *Adathoda vasica* @ | 38.27 | 45.5 | 39.2 | 39.1 | 784 | 1084 | 1187 | 9.89 |
| | 5% | (38.2) | (42.4) | (38.8) | (39.8) | | | | |
| 4. | Cow urine @ 10% + *Prosopis juliflora* @ | 45.68 | 39.6 | 48.2 | 40.3 | 838 | 1182 | 1307 | 10.77 |
| | 5% | (42.5) | (39.0) | (43.9) | (41.8) | | | | |
| 5. | Cow urine @ 10% + Neem oil @ 0.5% | 40.74 | 45.5 | 52.6 | 46.2 | 845 | 1046 | 1197 | 10.60 |
| | | (39.6) | (42.4) | (46.5) | (42.8) | | | | |
| 6. | Cow urine @ 10% + *Trichoderma* sp. @ | 48.15 | 45.2 | 52.6 | 41.7 | 868 | 1042 | 1249 | 10.54 |
| | 0.5% | (43.9) | (42.3) | (46.5) | (44.2) | | | | |
| 7. | Cow urine @ 10% + | 45.68 | 41.9 | 58.3 | 41.9 | 897 | 1111 | 1167 | 9.72 |
| | Potasium phosphonate @ 0.3 % | (42.5) | (40.3) | (49.8) | (44.7) | | | | |
| 8. | Cow urine @ 10% + Cristol 56 SL @ | 40.74 | 41.8 | 55.6 | 39.9 | 796 | 1137 | 1237 | 10.25 |
| | 0.5% | (39.6) | (40.3) | (48.2) | (41.2) | | | | |
| 9. | Cow urine @ 10% + | 32.10 | 43.7 | 49.6 | 39.3 | 710 | 1006 | 1211 | 10.28 |
| | *Pongamia pinnata* oil @ 0.5% | (34.5) | (41.4) | (55.8) | (40.2) | | | | |
| 10. | Cow urine @ 10% | 34.57 | 45.9 | 54.1 | 40.3 | 679 | 1164 | 1256 | 10.33 |
| | | (36.0) | (42.6) | (47.3) | (41.9) | | | | |
| 11. | Neem oil @ 1% | 43.21 | 40.6 | 46.7 | 39.9 | 777 | 1071 | 1259 | 10.36 |
| | | (41.1) | (39.6) | (43.1) | (41.2) | | | | |
| 12. | Hexaconazole @ 0.1% | 17.29 | 32.2 | 28.8 | 28.4 | 970 | 1233 | 1422 | 12.08 |
| | | (24.6) | (32.6) | (32.5) | (32.2) | | | | |
| 13. | Control | 67.89 | 86.7 | 94.1 | 84.5 | 678 | 852 | 927 | 8.79 |
| | | (55.5) | (68.6) | (75.9) | (66.8) | | | | |
| | S.E.± | 2.29 | 1.98 | 1.82 | 1.14 | 136.0 | 94.8 | 51.40 | 55.46 |
| | C.D. (P=0.05) | 6.69 | 4.95 | 5.30 | 3.53 | NS | NS | 150.04 | 170.91 |
| | CV (%) | 10.1 | 15.51 | 6.79 | 11.32 | 30.2 | 15.51 | 7.32 | 16.32 |

NS=Non-significant

presented in Table 3. The economics of the trial revealed that the maximum net income of Rs.15,925 in cow urine 10 per cent + *Prosopis juliflora* @0.5 per cent followed by Rs.15,475 in case of cow urine @ 10 per cent + neem oil @ 0.5 per cent.However,Hexaconazole @0.1 per cent recorded maximum net income of Rs.18,750 and minimum in untreated check (Rs.11,475) .With respect to B:C ratio, it was maximum in cow urine *10* per cent + *Prosopis juliflora* @0.5 per cent (1.45) followed by 1.41,1.34 in case of cow urine 10 per cent +neem oil @ 0.5 per cent and cow urine 10 per cent + *Trichoderma viride* @ 0.5 per cent, respectively. However, hexaconazole@ 0.1 per cent recorded B:C ratio of 1.64 and least B:C ratio in untreated control(1.12). This is a very good indication to develop an eco-friendly bio-intensive disease management strategy against Asian soybean rust in India. There is a need to further explore the role of defense genes being triggered by use of these elicitors leading to Induced Systemic Resistance (ISR) in soybean against Asian rust. The present investigations are the first line of research in managing Asian soybean rust by utilization of ITK measures. The successful management of panama disease of banana caused by *Fusarium oxysporum* f. sp. c*ubense*, foot rot of black pepper, TMV of tobacco and Fusarium wilt of tomato by use of neem based products and ITK measures has been reported by Shamarao

**Table 2: Evaluation of bio-rationales against soybean rust**

| Sr. No. | Treatments | Biochemical parameters | |
|---|---|---|---|
| | | Reducing sugars | Non reducing sugars |
| 1. | Cow urine @ 10% + $MnSO_4$ @ 0.3% | 0.393 | 9.45 |
| 2. | Cow urine @ 10% + Multik @ 0.5% | 0.423 | 8.41 |
| 3. | Cow urine @ 10% + *Adathoda vasica* @ 5% | 0.533 | 8.61 |
| 4. | Cow urine @ 10% + *Prosopis juliflora* @ 5% | 0.543 | 8.99 |
| 5. | Cow urine @ 10% + Neem oil @ 0.5% | 0.593 | 8.12 |
| 6. | Cow urine @ 10% + *Trichoderma* sp. @ 0.5% | 0.410 | 8.22 |
| 7. | Cow urine @ 10% + Potasium phosphonate @ 0.3 % | 0.647 | 7.88 |
| 8. | Cow urine @ 10% + Cristol 56 SL @ 0.5% | 0.530 | 7.61 |
| 9. | Cow urine @ 10% + *Pongamia pinnata* oil @ 0.5% | 0.590 | 8.82 |
| 10. | Cow urine @ 10% | 0.527 | 9.10 |
| 11. | Neem oil @ 1% | 0.597 | 9.18 |
| 12. | Hexaconazole @ 0.1% | 0.660 | 7.38 |
| 13. | Control | 0.383 | 7.01 |
| | S.E.± | 0.118 | 0.56 |
| | C.D. (P=0.01) | NS | NS |

NS=Non-significant

**Table 3: Evaluation of bio-rationales against soybean rust**

| Sr. No. | Treatments | Economics | | | | |
|---|---|---|---|---|---|---|
| | | Seed yield (kg/ha) | Gross Income | Cost of production | Net Income | C:B ratio |
| 1. | Cow urine @ 10% + $MnSO_4$ @ 0.3% | 9.32 | 23300 | 13416 | 9884 | 1:0.74 |
| 2. | Cow urine @ 10% + Multik @ 0.5% | 10.35 | 25875 | 11886 | 13989 | 1:1.18 |
| 3. | Cow urine @ 10% + *Adathoda vasica* @ 5% | 9.89 | 24725 | 11000 | 13725 | 1:1.21 |
| 4. | Cow urine @ 10% + *Prosopis juliflora* @ 5% | 10.77 | 26925 | 11000 | 15925 | 1:1.45 |
| 5. | Cow urine @ 10% + Neem oil @ 0.5% | 10.60 | 26500 | 11025 | 15475 | 1:1.41 |
| 6. | Cow urine @ 10% + *Trichoderma* sp. @ 0.5% | 10.54 | 26350 | 11250 | 15100 | 1:1.34 |
| 7. | Cow urine @ 10% + Potasium phosphonate @ 0.3 % | 9.72 | 24300 | 12300 | 12000 | 1:0.97 |
| 8. | Cow urine @ 10% + Cristol 56 SL @ 0.5% | 10.25 | 25625 | 12375 | 13250 | 1:1.07 |
| 9. | Cow urine @ 10% + *Pongamia pinnata* oil @ 0.5% | 10.28 | 25700 | 12750 | 12950 | 1:1.02 |
| 10. | Cow urine @ 10% | 10.33 | 25825 | 11000 | 14825 | 1:1.34 |
| 11. | Neem oil @ 1% | 10.36 | 25900 | 11550 | 14350 | 1:1.24 |
| 12. | Hexaconazole @ 0.1% | 12.08 | 30200 | 11450 | 18750 | 1:1.64 |
| 13. | Control | 8.79 | 21975 | 10500 | 11475 | 1:1.12 |

Jahagirdar,1998; Shamarao Jahagirdar *et al*., 2000; 2003; 2008; HollyBorn and Steve Diver, 2005 ).

**Conclusion:**

The chemical elicitors like $MnSO_4$,Multi-k or plant based extracts like *A.vesica*.*Pongamia pinnata* oil and bioagent like *Trichoderma harzianum* along with cow urine be used in developing integrated disease management strategies against Asian soybean rust in India which will help in reducing the chemical pesticides in long term sustainable management. The present findings drawn the first line of research on utilization of Indigenous Technology Knowledge in managing rust and enhancing both yield and quality parameters of soybean in India.

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